MITSUBISHI

MELSEC WS series

Safety Controller User's Manual



WS0-CPU0
WS0-CPU1
WS0-XTDI
WS0-XTIO
WS0-4RO

Powered by SICK

MELSEC-WS series products are jointly developed and manufactured by Mitsubishi and SICK AG, Industrial Safety Systems in Germany.
* Note that the warranty on MELSEC-WS series products differs from that on MELSEC-Q or MELSEC-QS series products. (Refer to "Warranty" written in this manual.)

This document is protected by the law of copyright, whereby all rights established therein remain with the company Mitsubishi Electric Corporation. Reproduction of this document or parts of this document is only permissible within the limits of the legal determination of Copyright Law. Alteration or abridgement of the document is not permitted without the explicit written approval of the company Mitsubishi Electric Corporation.

Precautions regarding warranty and specifications

MELSEC-WS series products are jointly developed and manufactured by Mitsubishi and SICK AG, Industrial Safety Systems, in Germany.

Note that there are some precautions regarding warranty and specifications of MELSEC-WS series products.

<Warranty>

- The gratis warranty term of the product shall be for one (1) year after the date of delivery or for eighteen (18) months after manufacturing, whichever is less.
- The onerous repair term after discontinuation of production shall be for four (4) years.
- Mitsubishi shall mainly replace the product that needs a repair.
- It may take some time to respond to the problem or repair the product depending on the condition and timing.

<Specifications>

- General specifications of the products differ.

	MELSEC-WS	**MELSEC-Q, MELSEC-QS**
Operating ambient temperature	-25 to 55°C	0 to 55°C
Operating ambient humidity	10 to 95%RH	5 to 95%RH
Storage ambient temperature	-25 to 70°C	-40 to 75°C
Storage ambient humidity	10 to 95%RH	5 to 95%RH

- EMC standards that are applicable to the products differ.

	MELSEC-WS	**MELSEC-Q, MELSEC-QS**
EMC standards	EN61000-6-2, EN55011	EN61131-2

● SAFETY PRECAUTIONS ●

(Read these precautions before using this product.)

Before using this product, please read this manual, the relevant manuals, and the safety standards carefully and pay full attention to safety to handle the product correctly.

In this manual, the safety precautions are classified into two levels: "⚠DANGER" and "⚠CAUTION".

⚠DANGER	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in minor or moderate injury or property damage.

Under some circumstances, failure to observe the precautions given under "⚠CAUTION" may lead to serious consequences.

Observe the precautions of both levels because they are important for personal and system safety.

Make sure that the end users read this manual and then keep the manual in a safe place for future reference.

[Design Precautions]

⚠DANGER

- When the MELSEC-WS safety controller detects a fault in the external power supply or itself, it turns off the outputs. Configure an external circuit so that the connected devices are powered off according to the output status (off) of the MELSEC-WS safety controller. Incorrect configuration may result in an accident.
- When a load current exceeding the rated current or an overcurrent caused by a load short-circuit flows for a long time, it may cause smoke and fire. To prevent this, configure an external safety circuit, such as a fuse.
- For safety relays, configure an external circuit using a device such as a fuse or breaker to protect a short-circuit current.
- When changing data and operating status, and modifying program of the running MELSEC-WS safety controller from the PC, configure a safety circuit in the sequence program or external to the MELSEC-WS safety controller to ensure that the entire system operates safely.
  Before operating the MELSEC-WS safety controller, read the relevant manuals carefully and determine the operating procedure so that the safety can be ensured.
  Furthermore, before performing online operations for the MELSEC-WS safety controller from the PC, determine corrective actions to be taken for communication errors caused by failure such as a poor contact.
- Create an interlock program using a reset button to prevent the MELSEC-WS safety controller from restarting automatically after the safety function is activated and the safety controller turns off the outputs.

⚠ CAUTION

- Ensure that an entire system using the MELSEC-WS safety controller meets the requirements for the corresponding safety category.
- The life of safety relays in the safety relay output module depends on the switching condition and/or load. Configure a system satisfying the number of switching times of the safety relays in the module.
- Do not install the communication cables together with the main circuit lines or power cables. Keep a distance of 100 mm or more between them.
  Failure to do so may result in malfunction due to noise.
- **Observe the protective notes and measures.**
  Observe the following items in order to ensure proper use of the MELSEC-WS safety controller.
  - When mounting, installing and using the MELSEC-WS safety controller, observe the standards and directives applicable in your country.
  - The national/international rules and regulations apply to the installation, use and periodic technical inspection of the MELSEC-WS safety controller, in particular.
    - Machinery Directive 98/37/EC (from 29.12.2009 Machinery Directive 2006/42/EC)
    - EMC Directive 2004/108/EC
    - Provision and Use of Work Equipment Directive 89/655/EC
    - Low-Voltage Directive 2006/95/EC
    - The work safety regulations/safety rules
  - Manufacturers and owners of the machine on which a MELSEC-WS safety controller is used are responsible for obtaining and observing all applicable safety regulations and rules.
  - The notices, in particular the test notices of this manual (e.g. on use, mounting, installation or integration into the existing machine controller), must be observed.
  - The test must be carried out by specialised personnel or specially qualified and authorized personnel and must be recorded and documented and retraced at any time by third parties.
  - The external voltage supply of the device must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204.
  - The modules of the MELSEC-WS safety controller conform to Class A, Group 1, in accordance with EN 55011. Group 1 encompasses all the ISM devices in which intentionally generated and/or used conductor-bound RF energy that is required for the inner function of the device itself occurs.
- **The MELSEC-WS safety controller fulfils the requirements of Class A (industrial applications) in accordance with the "Interference emission" basic specifications.**
  The MELSEC-WS safety controller is therefore only suitable for use in an industrial environment and not for private use.

[Installation Precautions]

DANGER

- Do not use the MELSEC-WS safety controller in flammable gas atmosphere or explosive gas atmosphere. Doing so may result in a fire or explosion due to such as an arc caused by switching the relays.

CAUTION

- Use the MELSEC-WS safety controller in an environment that meets the general specifications in this manual. Failure to do so may result in electric shock, fire, malfunction, or damage to or deterioration of the product.
- Latch the module onto the DIN rail. Incorrect mounting may cause malfunction, failure or drop of the module.
- To ensure full electromagnetic compatibility (EMC), the DIN mounting rail has to be connected to functional earth (FE).
  Ensure that the earthling contact is positioned correctly. The earthling spring contact of the module must contact the DIN rail securely to allow electrical conductivity.
- Shut off the external power supply for the system in all phases before mounting or removing the module. Failure to do so may result in damage to the product.
- Do not directly touch any conductive part of the module.
  Doing so can cause malfunction or failure of the module.
- The MELSEC-WS safety controller is only suitable for mounting in a control cabinet with at least IP 54 degree of protection.

[Wiring Precautions]

DANGER

- Shut off the external power supply for the system in all phases before wiring.
  Failure to do so may result in electric shock or damage to the product.
  The system could start up unexpectedly while you are connecting the devices.

CAUTION

- Ground the FG and LG terminals to the protective ground conductor dedicated to the MELSEC-WS safety controller.
  Failure to do so may result in electric shock or malfunction.
- Check the rated voltage and terminal layout before wiring to the module, and connect the cables correctly.
  Connecting a power supply with a different voltage rating or incorrect wiring may cause a fire or failure.
- Tighten the terminal screw within the specified torque range.
  Undertightening can cause short circuit, fire, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- Prevent foreign matter such as dust or wire chips from entering the module.
  Such foreign matter can cause a fire, failure, or malfunction.
- Mitsubishi MELSEC-WS safety controllers must be installed in control cabinets. Connect the main power supply to the MELSEC-WS safety controller through a relay terminal block.
  Wiring and replacement of an external power supply must be performed by maintenance personnel who is familiar with protection against electric shock. (For wiring methods, refer to Chapter 7.)
- Place the cables in a duct or clamp them.
  If not, dangling cable may swing or inadvertently be pulled, resulting in damage to the module or cables or malfunction due to poor contact.

[Startup and Maintenance Precautions]

DANGER

- Do not touch any terminal while power is on.
  Doing so will cause electric shock.
- Shut off the external power supply for the system in all phases before cleaning the module or retightening the terminal screws. Failure to do so may result in electric shock.
  Tighten the terminal screw within the specified torque range. Undertightening can cause short circuit, fire, or malfunction.
  Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- **Safety-oriented devices must be suitable for safety related signals.**
  A function interruption of safety outputs results in a loss of the safety functions so that the risk of serious injury exists.
  Do not connect any loads that exceed the rated values of the safety outputs.
  Wire the MELSEC-WS safety controller so that 24 V DC signals cannot unintentionally contact safety outputs.
  Connect the GND wires of the power supply to earth so that the devices do not switch on when the safety output line is applied to frame potential.
  Use suitable components or devices that fulfill all the applicable regulations and standards. Actuators at the outputs can be wired single-channeled. In order to maintain the respective Safety Integrity Level the lines have to be routed in such a manner that cross circuits to other live signals can be excluded, for example by routing them within protected areas such as in a control cabinet or in separate sheathed cables.

⚠ CAUTION
● Before performing online operations (Force mode) for the running MELSEC-WS safety controller from the PC, read the relevant manuals carefully and ensure the safety. The online operations must be performed by qualified personnel, following the operating procedure determined at designing. Fully understand the precautions described in the Safety Controller Setting and Monitoring Tool Operating Manual before use. ● Do not disassemble or modify the modules. Doing so may cause failure, malfunction, injury, or a fire. Mitsubishi does not warrant any products repaired or modified by persons other than Mitsubishi or FA Center authorized by Mitsubishi. ● Shut off the external power supply for the MELSEC-WS safety controller in all phases before mounting or removing the module. Failure to do so may cause the module to fail or malfunction. ● After the first use of the product, do not mount/remove the module from/to the DIN rail, and the terminal block to/from the module more than 50 times (IEC 61131-2 compliant) respectively. Exceeding the limit of 50 times may cause malfunction. ● Before handling the module, touch a grounded metal object to discharge the static electricity from the human body. Failure to do so may cause the module to fail or malfunction.

[Disposal Precautions]

⚠ CAUTION
● When disposing of this product, treat it as industrial waste. Disposal of the product should always occur in accordance with the applicable country-specific waste-disposal regulations (e.g. European Waste Code 16 02 14).

REVISIONS

*The manual number is given on the bottom left of the back cover.

Print date	*Manual number	Revision
September, 2009	SH-(NA)-080855ENG-A	First edition

Japanese manual version SH-080852-A

This manual confers no industrial property rights or any rights of any other kind, nor does it confer any patent licenses. Mitsubishi Electric Corporation cannot be held responsible for any problems involving industrial property rights which may occur as a result of using the contents noted in this manual.

© 2009 MITSUBISHI ELECTRIC CORPORATION

CONTENTS

SAFETY PRECAUTIONS 1
REVISIONS 7
CONTENTS 8
GENERIC TERMS AND ABBREVIATIONS 11
1 About this document 12
1.1 Function of this document 12
1.2 Target group 13
1.3 Depth of information 14
1.4 Scope 14
1.5 Abbreviations used 15
1.6 Symbols used 15
2 On safety 16
2.1 Qualified safety personnel 16
2.2 Applications of the device 16
2.3 Correct use 17
2.4 General protective notes and protective measures 18
2.5 Environmental protection 19
2.5.1 Disposal 19
2.5.2 Material separation 19
3 Product description 20
3.1 System properties 20
3.2 System configuration 21
3.3 Memory plug WS0-MPL 22
3.4 CPU module WS0-CPU0 23
3.4.1 Description 23
3.4.2 Display elements and terminal description 23
3.5 CPU module WS0-CPU1 25
3.5.1 Description 25
3.5.2 Display elements and terminal description 26
3.6 WS0-XTIO safety I/O combined module 27
3.6.1 Description 27
3.6.2 Display elements and terminal description 28
3.7 WS0-XTDI safety input module 30
3.7.1 Description 30
3.7.2 Display elements and terminal description 30
3.8 WS0-4RO safety relay output module 31
3.8.1 Description 31
3.8.2 Display elements and terminal description 32

4 Connecting devices 34
4.1 Safety command devices and electro-mechanical safety switches 36
4.1.1 Emergency stop pushbuttons (e.g. SICK ES21) 36
4.1.2 Electro-mechanical safety switches with and without interlock (e.g. SICK I10, I100 and I1000) 37
4.1.3 Enabling switch (e.g. SICK E100) 38
4.1.4 Two-hand control 39
4.1.5 Safety mats 39
4.1.6 Operating mode selector switch 40
4.1.7 Floating contacts 40
4.2 Non-contact safety sensors 41
4.2.1 Magnetic safety switches (e.g. SICK RE) 41
4.2.2 Inductive safety switches (e.g. SICK IN4000, IN40 Direct) 42
4.2.3 Transponder (e.g. SICK T4000 Compact, T40 Direct) 42
4.3 Testable single-beam photoelectric safety switches 43
4.3.1 Testable Type 2 single-beam photoelectric safety switches (e.g. SICK Wx12/18/24/27) 43
4.3.2 Testable Type 4 single-beam photoelectric safety switches 44
4.3.3 Information for mounting testable single-beam photoelectric safety switches 45
4.4 Electro-sensitive protective equipment (ESPE) 47
4.5 Outputs 47
4.6 EFI devices 48
4.6.1 EFI communication and EMC 48
5 Special functions 49
5.1 Enhanced Function Interface - EFI 49
5.1.1 Definition 49
5.1.2 Properties 49
5.1.3 Functions 50
5.1.4 Benefits 50
5.2 Muting 51
5.2.1 General description 51
5.2.2 SICK muting sensors 51
6 Mounting/Dismantling 52
6.1 Steps for mounting the modules 52
6.2 Steps for dismantling the modules 54
7 Electrical installation 56
8 Configuration 58

9 Commissioning 59
9.1 Full approval of the application 59
9.2 Tests before the initial commissioning 60
10 Diagnostics 61
10.1 In the event of faults or errors 61
10.2 Mitsubishi support 61
10.3 Error display of the MS and CV status LEDs 61
10.4 Additional error displays of EFI-compatible devices 62
10.5 Extended diagnostics 62
11 Maintenance 63
11.1 Regular inspection of the protective device by qualified safety personnel 63
11.2 Device replacement 64
12 Technical data 65
12.1 Response times of the MELSEC-WS safety controller 65
12.2 Data sheet 69
12.2.1 WS0-CPU0 and WS0-CPU1 modules 69
12.2.2 WS0-XTIO safety input/output combined module 70
12.2.3 WS0-XTDI safety input module 72
12.2.4 WS0-4RO safety relay output module 74
12.3 Dimensional drawings 76
12.3.1 WS0-CPU0/CPU1 module with memory plug 76
12.3.2 WS0-XTIO module, WS0-XTDI module, and WS0-4RO module 76
13 Ordering information 77
13.1 Available modules and accessories 77
14 Annex 78
14.1 EC declaration of conformity 78
14.2 Manufacturers checklist 78
14.3 Wiring examples 79
14.4 Troubleshooting 87
14.4.1 Basics of troubleshooting 87
14.4.2 Troubleshooting flowchart (for CPU module) 88
14.4.3 Troubleshooting flowchart (for safety I/O module) 94
14.5 SICK contact 102

GENERIC TERMS AND ABBREVIATIONS

Generic term/abbreviation	Description
WS0-MPL	Abbreviation for the WS0-MPL00201 MELSEC-WS safety controller memory plug
WS0-CPU0	Abbreviation for the WS0-CPU000200 MELSEC-WS safety controller CPU module
WS0-CPU1	Abbreviation for the WS0-CPU130202 MELSEC-WS safety controller CPU module
WS0-XTIO	Abbreviation for the WS0-XTIO84202 MELSEC-WS safety controller safety I/O combined module
WS0-XTDI	Abbreviation for the WS0-XTDI80202 MELSEC-WS safety controller safety input module
WS0-4RO	Abbreviation for the WS0-4RO4002 MELSEC-WS safety controller safety relay output module
WS0-GETH	Abbreviation for the WS0-GETH00200 MELSEC-WS safety controller Ethernet interface module
CPU module	Generic term for the WS0-CPU0 and WS0-CPU1
Safety I/O module	Generic term for the WS0-XTIO and WS0-XTDI
Network module	Another name for the WS0-GETH

1 About this document

Please read the Chapter 1 and Chapter 2 carefully before working with this documentation and the MELSEC-WS safety controller.

1.1 Function of this document

For the MELSEC-WS safety controller there are three manuals with clearly distinguished fields of application as well as User's Manuals (Hardware) for each module.

- This manual describes all the MELSEC-WS modules and their functions in detail. Use this manual in particular to configure MELSEC-WS safety controllers. The manual instructs the technical staff of the machine manufacturer and/or of the machine operator on the safe mounting, electrical installation, commissioning as well as maintenance of the MELSEC-WS safety controller. The manual does not provide instructions for operating the machine in which the safety controller is, or will be, integrated. Information of this kind will be found in the manuals for the machine.
- The Safety Controller Setting and Monitoring Tool Operating Manual describes the software-supported configuration and parameterization of the MELSEC-WS safety controller. In addition the manual contains the description of the diagnostics functions that are important for operation and detailed information for the identification and elimination of errors. Use the manual in particular for the configuration, commissioning and operation of MELSEC-WS safety controllers.
- The Safety Controller Ethernet Interface Module User's Manual describes important information on the configuration of the Ethernet interface module.
- The User's Manuals (Hardware) are enclosed with each MELSEC-WS module. They inform on the basic technical specifications of the modules and contain simple mounting instructions. Use the User's Manuals (Hardware) when mounting the MELSEC-WS safety controller.

The following shows the relevant manuals.

Title	Number
Safety Controller User’s Manual	WS-CPU-U-E (13JZ32)
Safety Controller Ethernet Interface Module User’s Manual	WS-ET-U-E (13JZ33)
Safety Controller Setting and Monitoring Tool Operating Manual	SW1DNN-WS0ADR-B-O-E (13JU67)
Safety Controller CPU Module User's Manual (Hardware)	WS-CPU-U-HW (13J200)
Safety Controller Safety I/O Module User's Manual (Hardware)	WS-IO-U-HW (13J201)
Safety Controller Safety Relay Output Module User's Manual (Hardware)	WS-SR-U-HW (13J202)
Safety Controller Ethernet Interface Module User's Manual (Hardware)	WS-ET-U-HW (13J203)

1.2 Target group

This manual is addressed to the planning engineers, designers and operators of systems which are to be protected by a MELSEC-WS safety controller. It also addresses people who integrate the MELSEC-WS safety controller into a machine, commission it initially or who are in charge of servicing and maintaining the unit.

1.3 Depth of information

This manual contains information on the MELSEC-WS safety controller in the following subjects:

- Mounting
- Electrical installation
- Hardware commissioning
- Maintenance
- Error diagnostics and remedying
- Part numbers
- Conformity and approval

Planning and using other company's protective devices also require specific technical skills which are not detailed in this documentation.

When operating the MELSEC-WS safety controller, the national, local and statutory rules and regulations must be observed.

Note For the acquisition of Setting and Monitoring Tool, please contact your local Mitsubishi representative.

The EFI-compatible devices and SICK configuration and diagnostics software CDS are the products of SICK.

For details of the SICK products, please contact your local SICK representative (see Annex, Section 14.5).

http://www.sens-control.com

1.4 Scope

This manual is valid for all modules of the MELSEC-WS safety controller with the exception of the network modules.

This document is the original manual.

1.5 Abbreviations used

ESPE Electro-sensitive protective equipment (e.g. light curtains)

EDM External device monitoring

EFI Enhanced Function Interface

PFHD Probability of dangerous failure per hour

OSSD Output signal switching device

SIL Safety Integrity Level (safety class)

SIL CL Safety Integrity Level Claim

1.6 Symbols used

Recommendation Recommendations are designed to give you some assistance in your decision-making process with respect to a certain function or a technical measure.

Note Notes provide special information on the device.

●Red, ○Red, ☀ Green LED symbols describe the state of a diagnostics LED. Examples:

●Red The red LED is illuminated constantly.

○Red The red LED is flashing.

☀Green The green LED is off.

⇒ Action Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

ATTENTION

Warning!
An “ATTENTION” indicates concrete or potential dangers. They save you from harm.Read warnings carefully and abide by them!

2 On safety

This chapter deals with your own safety and the safety of the equipment operators.

- Please read this chapter carefully before working with the MELSEC-WS safety controller or with the machine protected by the MELSEC-WS safety controller.

2.1 Qualified safety personnel

The MELSEC-WS safety controller may only be installed, commissioned and serviced by qualified safety personnel.

- Qualified safety personnel are defined as persons who …
- have undergone the appropriate technical training
  and
- have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines
  and
- have access to the MELSEC-WS manuals and have read and familiarised themselves with them
  and
- have access to the manuals for the protective devices (e.g. light curtain) connected to the safety controller and have read and familiarised themselves with them.

2.2 Applications of the device

MELSEC-WS safety controller is a configurable controller for safety applications. It can be used

- in accordance with EN 61508 to SIL3
- in accordance with EN 62061 to SILCL3
- in accordance with EN ISO 13849-1 up to Performance Level e
- in accordance with EN954-1[*1] up to Category 4

The degree of safety actually attained depends on the external circuit, the realization of the wiring, the parameter configuration, the choice of the pick-ups and their location at the machine.

Opto-electronic and tactile safety sensors (e.g. light curtains, laser scanners, safety switches, sensors, emergency stop pushbuttons) are connected to the safety controller and are linked logically. The corresponding actuators of the machines or systems can be switched off safely via the switching outputs of the safety controller.

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

2.3 Correct use

The MELSEC-WS safety controller may only be used within specific operating limits (voltage, temperature, etc., refer to the technical data in Chapter 12) in the sense of Section 2.2. It may only be used by specialist personnel and only at the machine at which it was mounted and initially commissioned by qualified safety personnel in accordance with the MELSEC-WS manuals.

Mitsubishi Electric Corporation accepts no claims for liability if the equipment is used in any other way or if modifications are made to the device, even in the context of mounting and installation.

- The external voltage supply of the device must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204.
- The MELSEC-WS safety controller may not start up normally when power is restored immediately after the external power supply has been shut off (within 5 seconds). To restore the power, wait for 5 or more seconds after power-off.
- For UL/CSA applications:
  Use 60°C /75°C conductors.

  The terminal tightening torque must be 5 to 7 lbs/in.

  To be used in a Pollution Degree 2 environment only.
- The modules of the MELSEC-WS safety controller conform to Class A, Group 1, in accordance with EN 55011.
  Group 1 encompasses all the ISM devices in which intentionally generated and/or used conductor-bound RF energy that is required for the inner function of the device itself occurs.



ATTENTION

The MELSEC-WS safety controller fulfils the requirements of Class A (industrial applications) in accordance with the “Interference emission” basic specifications.
The MELSEC-WS safety controller is therefore only suitable for use in an industrial environment and not for private use.

2.4 General protective notes and protective measures

ATTENTION

Observe the protective notes and measures!
Please observe the following items in order to ensure proper use of the MELSEC-WS safety controller.

- When mounting, installing and using the MELSEC-WS safety controller, observe the standards and directives applicable in your country.
- The national/international rules and regulations apply to the installation, use and periodic technical inspection of the MELSEC-WS safety controller, in particular:
  - Machinery Directive 98/37/EC
    (from 29.12.2009 Machinery Directive 2006/42/EC)
  - EMC Directive 2004/108/EC
  - Provision and Use of Work Equipment Directive 89/655/EC
  - Low-Voltage Directive 2006/95/EC*1
  - The work safety regulations/safety rules
- Manufacturers and owners of the machine on which a MELSEC-WS safety controller is used are responsible for obtaining and observing all applicable safety regulations and rules.
- The notices, in particular the test notices (see Chapter 9) of this manual (e.g. on use, mounting, installation or integration into the existing machine controller) must be observed.
- The tests must be carried out by specialised personnel or specially qualified and authorised personnel and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time by third parties.
- This manual must be made available to the user of the machine where the MELSEC-WS safety controller is used. The machine operator is to be instructed in the use of the device by qualified safety personnel and must be instructed to read the manual.

*1 WS0-4RO only.

2.5 Environmental protection

The MELSEC-WS safety controller has been designed to minimise environmental impact. It uses only a minimum of power and natural resources.

- At work, always act in an environmentally responsible manner.

2.5.1 Disposal

Disposal of unusable or irreparable devices should always occur in accordance with the applicable country-specific waste-disposal regulations (e.g. European Waste Code 16 02 14).

2.5.2 Material separation



ATTENTION

Material separation may only be performed by qualified safety personnel!
Exercise care when disassembling the devices. The danger of injury is present.

Before you can turn over the devices for environmental-friendly recycling, you must separate the different materials of the MELSEC-WS module from one another.

- Separate the housing from the remaining components (especially the PCB).
- Send the separated components to the corresponding recycling centers (see the following table).

Table 1: Overview of disposal by component

Component	Disposal
Product Housing PCBs, cables, plugs and electrical connection pieces	 Plastic recycling Electronics recycling
Packaging Cardboard, paper	Paper/cardboard recycling

3 Product description

This chapter provides information on the features and properties of the MELSEC-WS safety controller and describes the structure and operating principle.

3.1 System properties

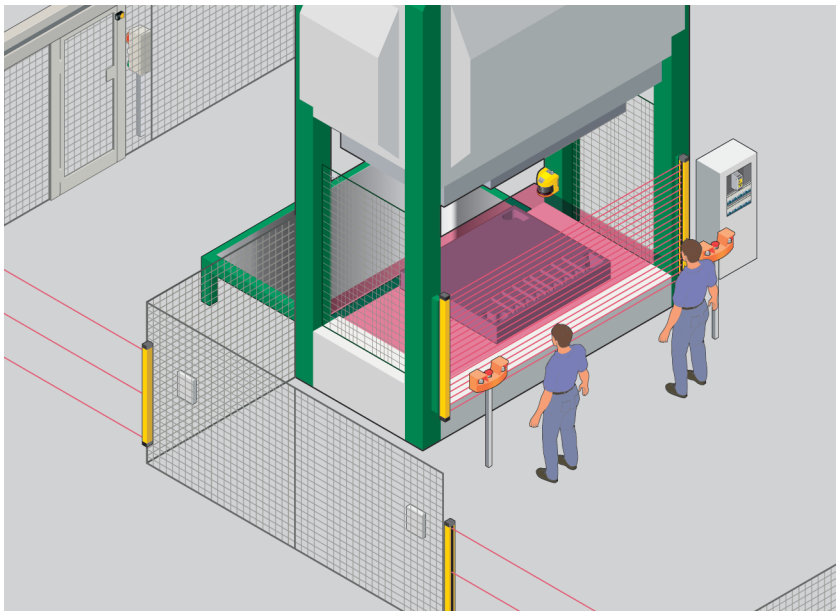


Figure 1: MELSEC-WS safety controller

The MELSEC-WS safety controller is characterised by the following system properties:

- Modular structure: 1 CPU module, up to 12 safety I/O modules, up to 4 safety relay output modules, and up to 2 different network modules each with 22.5 mm compact width
- 8 to 96 inputs and 4 to 48 outputs
- Programmable
- Use of up to 255 standard and application-specific logic blocks
- Standard logic blocks, e.g. AND, OR, NOT, XNOR, XOR
- Application-specific logic blocks, e.g. emergency stop, two-hand, muting, pressing, operating mode selector switch, reset, restart
- Integration in different networks via network modules possible (EtherNet/IP, Modbus TCP, PROFINET IO, PROFIBUS DP, DeviceNet and CANopen)
- 2 EFI interfaces at the WS0-CPU1, see Section 3.5

For the acquisition of Setting and Monitoring Tool, please contact your local Mitsubishi representative.

3.2 System configuration

A MELSEC-WS safety controller consists of the following modules:

- a WS0-MPL memory plug
- a WS0-CPU0 or WS0-CPU1 module
- up to 2 different network modules
- up to 12 additional WS0-XTIO and WS0-XTDI safety I/O modules
- in addition up to 4 WS0-4RO safety relay output modules

Figure 2:
Examples for the minimum configuration of a MELSEC-WS safety controller with CPU0 and XTDI or CPU1 and XTIO

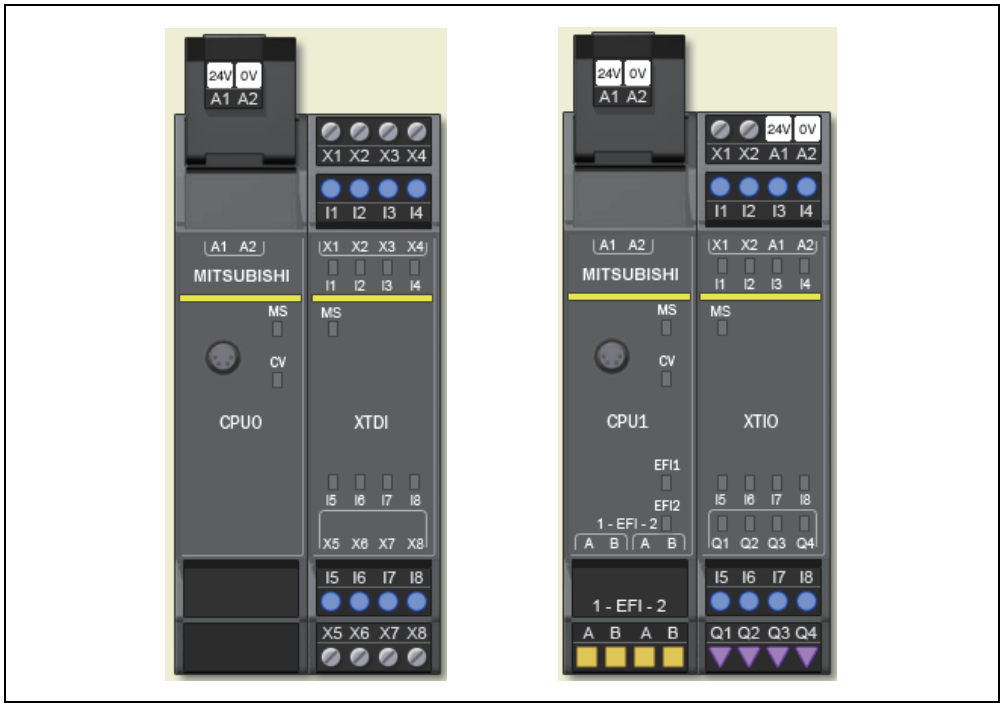


Figure 3:
Maximum configuration of the MELSEC-WS safety controller (without safety relay output module nor Ethernet interface module)

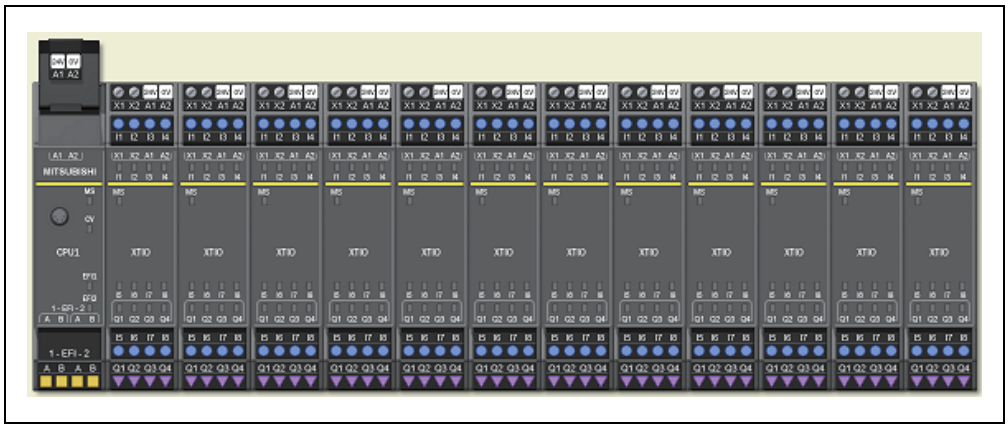


Table 2: Overview of the modules

Type	Kind	Inputs *2	Outputs *2	Logic blocks	Max. occurrence
WS0-CPU0	CPU module	-	-	255	1
WS0-CPU1		4*1	-		
WS0-XTIO	Safety I/O combined module	8	4	-	12
WS0-XTDI	Safety input module	8	-	-	
WS0-4RO	Safety relay output module	-	4	-	4
WS0-GETH	Ethernet interface module	-	-	-	2

*1 EFI terminals

*2 Single channel

3.3 Memory plug WS0-MPL

The system configuration of the complete MELSEC-WS safety controller is **only** stored in the memory plug. This offers the advantage when terminal modules are replaced that the MELSEC-WS safety controller does not have to be reconfigured.

Note Connected EFI-compatible devices have to be configured again when they are replaced.

The data stored in the memory plug are retained when the voltage supply is interrupted.

The CPU module and the inputs of the system are supplied with electricity exclusively through the memory plug. The outputs, on the other hand, are supplied separately.

Note The current of the power supply unit that supplies the CPU module has to be limited to a maximum of 4 A - either by the power supply unit itself or by a fuse.

If modules are replaced, ensure that the memory plug is plugged into the suitable CPU module. Uniquely mark all the connection cables and connectors at the MELSEC-WS safety controller in order to avoid confusion.

3.4 CPU module WS0-CPU0

3.4.1 Description

The WS0-CPU0 module is the central process unit of the entire system in which all the signals are monitored and processed logically in accordance with the configuration stored in the memory plug. The outputs of the system are switched as a result of the processing, whereby the FLEXBUS+ backplane bus serves as the data interface.

The CPU module furthermore has an RS-232 interface with the following functions:

- Transferring the configuration from the Setting and Monitoring Tool to the memory plug
- Uploading the configuration from the memory plug to the Setting and Monitoring Tool
- Diagnostics of the MELSEC-WS safety controller with the Setting and Monitoring Tool

Note The maximum permissible cable length is 3 m. The screen has to be shielded and connected at suitable points to the FE.

Avoid ground loops between the GND of the RS-232 interface and the connection A2 of the CPU module, e.g. by using optocouplers.

Note When the memory plug is not plugged in, ensure that no debris can enter the corresponding opening.

3.4.2 Display elements and terminal description

Figure 4:
Display elements
WS0-CPU0

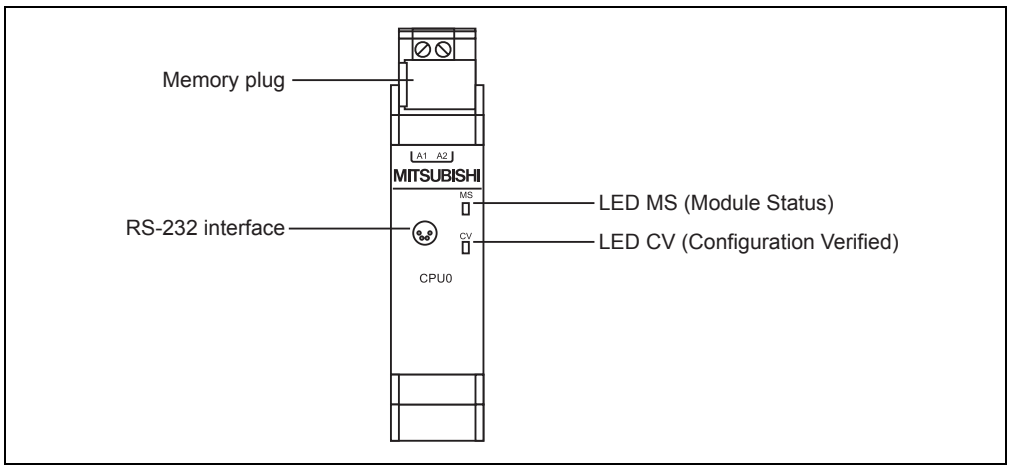


Table 3:
Memory plug pin assignment

Pin	Assignment
A1	24 V voltage supply for all the modules, with the exception of the outputs
A2	GND of the voltage supply

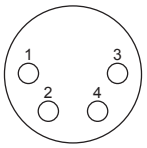
Table 4:
Displays of the MS LED

MS LED	Meaning	Notes
○	Supply voltage lies outside range.	Switch on the supply voltage and check it at the terminals A1 and A2.
☀ Red/green (1 Hz)	A self test is being carried out or the system is being initialized.	Please wait ...
☀ Green (1 Hz)	System is ready for operation.	In order to start the application press the Start button in the Setting and Monitoring Tool.
● Green	Application is being carried out.	
☀ Red (1 Hz)	Correctable error either in the CPU module or one of the safety I/O modules	Check the module type and version of the CPU module and safety I/O modules whose MS LED flashes red/green. If appropriate, adapt the configuration using the Setting and Monitoring Tool. For detailed diagnostics information, refer to the Setting and Monitoring Tool.
☀ Red (2 Hz)	Module has caused internal system error	Switch the supply voltage off and on again. If appropriate, adapt the configuration using the Setting and Monitoring Tool. For detailed diagnostics information, refer to the Setting and Monitoring Tool.
● Red	Critical error in the system	Switch the supply voltage off and on again. If the error is not eliminated after multiple repetitions, replace the module. In order to narrow down the respective module use the diagnostics display in the Setting and Monitoring Tool.

Table 5:
Displays of the CV LED

CV LED	Meaning	Note
○	Configuration required	
☀ Yellow (2Hz)	Storing of configuration data in the non-volatile memory	Supply voltage may not be interrupted until the storage process has been completed.
☀ Yellow (1Hz)	Valid but unverified configuration	Verify configuration with the Setting and Monitoring Tool.
● Yellow	Valid and verified configuration	

Table 6:
Pin assignment of the RS-232 interface

Plug/socket	Pin	Signal	Colour	Assignment PC-sided RS-232 SubD (9 pins)
	1	Reserved	Brown	-
	2	RxD	White	Pin 3
	3	GND (Internally electrically connected with connection A2 of the CPU module)	Blue	Pin 5
	4	TxD	Black	Pin 2

3.5 CPU module WS0-CPU1

3.5.1 Description

The WS0-CPU1 module has the same functions as the WS0-CPU0. Please observe the notes in Section 3.4.

In addition this module has 2 EFI interfaces. If intelligent SICK sensor equipment is connected, a functional extension at the sensors is then possible by simple means.

For further information about EFI interfaces refer to Section 5.1.

- Transferring the configuration from the Setting and Monitoring Tool to the memory plug and to the connected EFI-compatible devices
- Uploading the configuration from the memory plug and the connected EFI-compatible devices to the Setting and Monitoring Tool
- Diagnostics of the MELSEC-WS safety controller with the Setting and Monitoring Tool

Note The maximum permissible cable length is 3 m. The screen has to be shielded and connected at suitable points to the FE.

Avoid ground loops between the GND of the RS-232 interface and the connection A2 of the CPU module, e.g. by using optocouplers.

3.5.2 Display elements and terminal description

The displays of the MS and CV LEDs as well as the RS-232 interface are identical with those of the WS0-CPU0, see Section 3.4.2.

Figure 5:
Display elements
WS0-CPU1

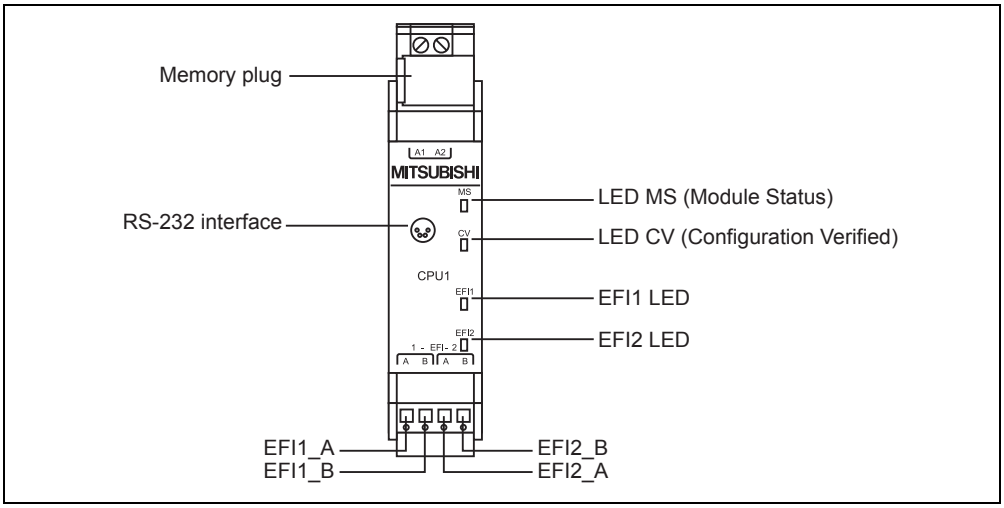


Table 7:
Displays of the EFI LEDs

EFI LED (EFI1 or EFI2)	Meaning	Note
○	OK	–
● Red	Error: Waiting for integration of EFI devices after power up	–
☀ Red (1 Hz)	Error: Integration check failed	Check the wiring.

3.6 WS0-XTIO safety I/O combined module

3.6.1 Description

The WS0-XTIO module is an input/output extension with 8 safety inputs and 4 safety outputs. It has two test signal generators: One for test output X1 and one for test output X2.

The WS0-XTIO module fulfills the following tasks:

- Monitoring of the connected sensor equipment, also refer to Chapter 4.
- Passing on the input information to the CPU module
- Receiving the control signals from the CPU module and corresponding switching of the outputs
- Fast Shut Off: Direct switching off of the actuators connected to the module possible.
  This leads to a considerable reduction of the response time of the overall system. For switching off outputs, only 8 ms have to be added to the response times of the devices connected to the inputs and outputs. The response time on the FLEXBUS+ backplane bus as well as the logic execution time is irrelevant in this case. See also Section 12.1.

The WS0-XTIO module cannot be used alone and always requires a WS0-CPU1 or WS0-CPU1 module. See the Safety Controller Setting and Monitoring Tool Operating Manual.

The simultaneous use of several WS0-XTIO modules is possible, see Section 3.2.

Voltage supply is effected via the FLEXBUS+ backplane bus.

Voltage supply of the outputs Q1 to Q4 is afftected directly at the WS0-XTIO module.

3.6.2 Display elements and terminal description

Figure 6:
Display elements
WS0-XTIO

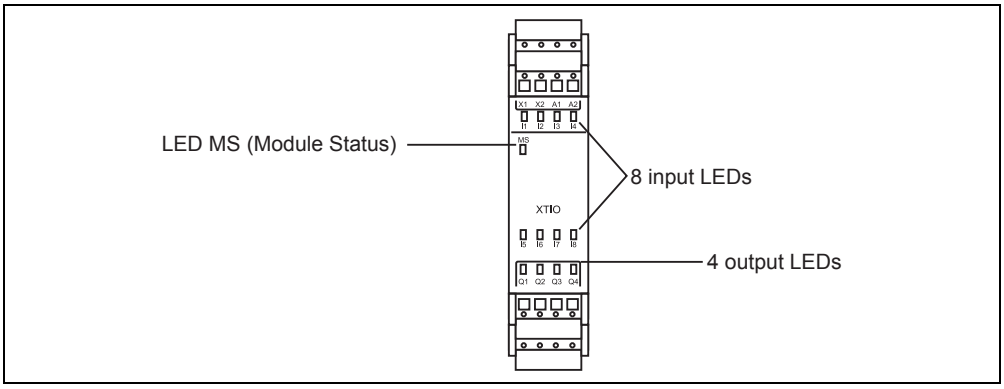


Table 8:
Terminal assignment
WS0-XTIO

Terminal	Assignment
X1/X2	Test output 1/test output 2
I1 to I4	Inputs 1 to 4
A1	24 V
A2	GND
I5 to I8	Inputs 5 to 8
Q1 to Q4	Outputs 1 to 4

Table 9:
Displays of the MS LED

MS LED	Meaning	Notes
○	Supply voltage is outside of tolerance.	Check the supply voltage at terminals A1 and A2.
☀ Red/green (1Hz)	Configuration required	-
☀ Green (1 Hz)	Module is ready for operation.	Start the application in the Setting and Monitoring Tool.
● Green	Application is being carried out.	
☀ Red (1Hz)	Recoverable external error	Check the wiring of the flashing inputs and outputs. If all the output LEDs flash, check the supply voltage at terminals A1 and A2 of this module.
● Red	Critical error in the system	Switch off the voltage supply of the CPU module and switch it on again. If the error is not eliminated after multiple repetitions, replace the module. In order to narrow down the respective module use the diagnostics display in the Setting and Monitoring Tool.

Table 10: Displays of the input/output LEDs

Input LEDs (I1 to I8) Output LEDs (Q1 to Q4)	Meaning
○	Input/output is inactive.
● Green	Input/output is active.
☀ Green (1 Hz) synchronous with the red MS LED	Input/output is inactive and there is a correctable error.
☀ Green (1 Hz) alternatively with the red MS LED	Input/output is active and there is a correctable error.

3.7 WS0-XTDI safety input module

3.7.1 Description

The WS0-XTDI module is the input extension with 8 safe inputs. It fulfills the following tasks:

- Monitoring of the connected sensor equipment, also refer to Chapter 4.
- Passing on the input information to the CPU module

The WS0-XTDI module cannot be used alone and always requires a WS0-CPU0 or WS0-CPU1 module. See the Safety Controller Setting and Monitoring Tool Operating Manual.

The simultaneous use of several WS0-XTDI modules is possible, see Section 3.2.

Voltage supply is effected via the FLEXBUS+ backplane bus.

A WS0-XTDI has two test signal generators. One test signal generator is responsible for the odd-numbered test outputs X1, X3, X5 and X7, the other for the even-numbered test outputs X2, X4, X6 and X8.

Note Take the following points into account for the wiring:

- The WS0-XTDI recognises short-circuits between odd-numbered (X1, X3, X5, X7) and even-numbered (X2, X4, X6, X8) test outputs.
- Short-circuits under the odd-numbered (X1, X3, X5, X7) or under the even-numbered (X2, X4, X6, X8) test outputs are not recognised.

3.7.2 Display elements and terminal description

The displays of the MS LED as well as the input LEDs I1 to I8 are identical with those of the WS0-XTIO, see Section 3.6.2.

Figure 7:
Display elements
WS0-XTDI

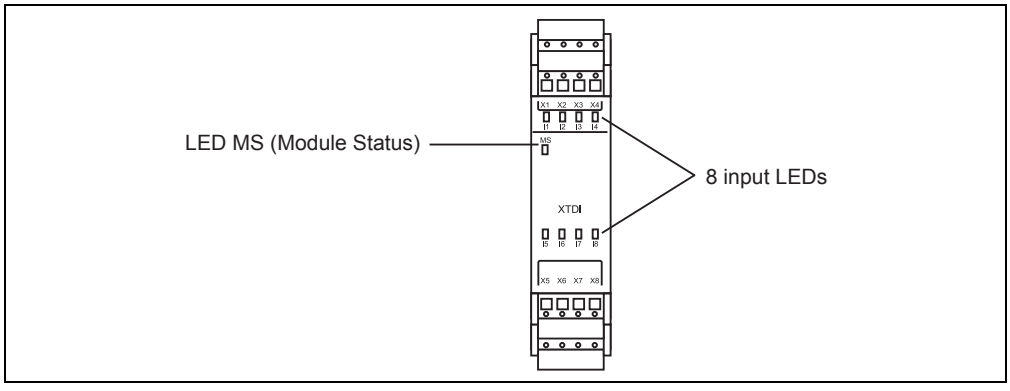


Table 11: Terminal assignment WS0-XTDI

Terminal	Assignment
X1/X3	Test output 1
X2/X4	Test output 2
I1 to I4	Inputs 1 to 4
I5 to I8	Inputs 5 to 8
X5/X7	Test output 1
X6/X8	Test output 2

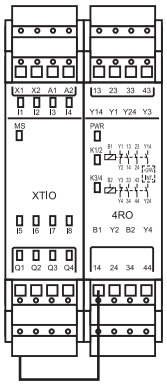
3.8 WS0-4RO safety relay output module

3.8.1 Description

The WS0-4RO safety relay output module makes dual-channel contact-based outputs with “positively driven relay contacts” available.

The WS0-4RO safety relay output module cannot be used independently, but are switched via a WS0-XTIO module. To this purpose a control output of the WS0-XTIO module (Q1 to Q4) has to be jumpered to a control input of the relay output module (B1, B2), see the following figure.

Figure 8: Example of the inclusion of a relay output module in the MELSEC-WS safety controller



Note The relay output modules are not nodes on the FLEXBUS+ backplane bus. Control signals cannot therefore be received from the CPU module.

A max. of 4 WS0-4RO safety relay output modules can be connected to a MELSEC-WS safety controller, i.e. a maximum of 16 safe relay outputs are available.

The WS0-4RO has two control inputs (B1, B2). These control two times two internal relays that form two independently redundant switch-off paths.

Control input (B1) controls two internal relays and forms a redundant switch-off path consisting of:

- two safe enabling circuits (13/14, 23/24), dual-channel and floating,
- a signaling circuit (Y14), dual-channel and non-isolated,
- a feedback EDM (Y1/Y2), dual-channel and floating.

Control input (B2) controls two internal relays and forms a redundant switch-off path consisting of:

- two safe enabling circuits (33/34, 43/44), dual-channel and floating,
- a signaling circuit (Y24), dual-channel and non-isolated,
- a feedback EDM (Y3/Y4), dual-channel and floating.

3.8.2 Display elements and terminal description

Figure 9:
Internal configuration
WS0-4RO

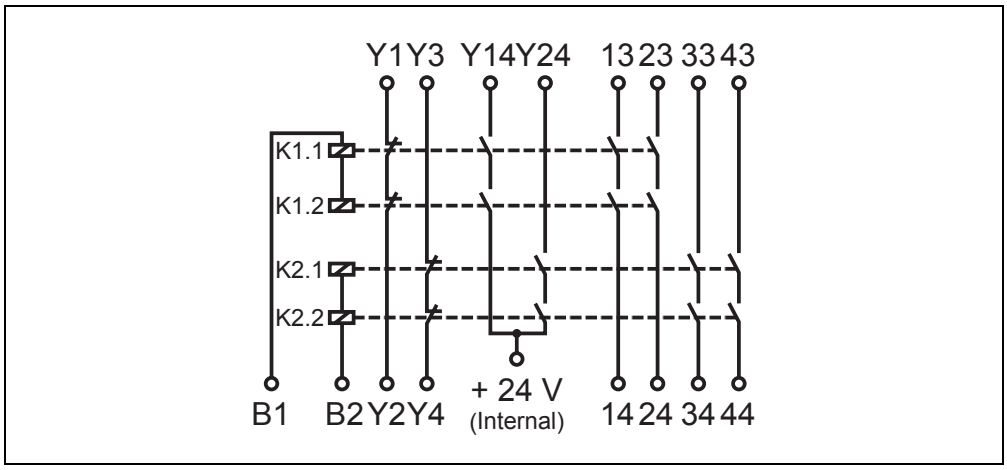


Figure 10:
WS0-4RO display element

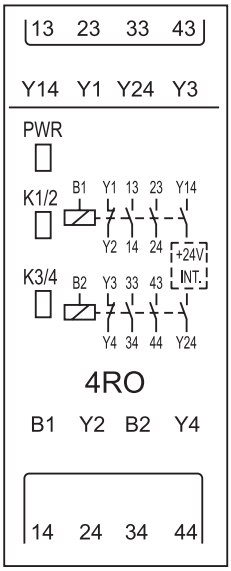


Table 12:
WS0-4RO displays

Display	Meaning
PWR (green)	Supply voltage via safety bus is applied
K1/2 (green)	Relay K1/K2 - safety contacts closed
K3/4 (green)	Relay K3/K4 - safety contacts closed

Table 13:
WS0-4RO terminals

Assignment	Description
B1	Circuiting relay K1/K2
B2	Circuiting relay K3/K4
13/14 and 23/24	Safety contacts for switch-off circuit outputs K1/K2
33/34 and 43/44	Safety contacts for switch-off circuit outputs K3/K4
Y1/Y2	Feedback EDM K1/K2 NC contact
Y3/Y4	Feedback EDM K3/K4 NC contact
Y14	NO contact safety contact K1/K2, current-limited (see Chapter 12)
Y24	NO contact safety contact K3/K4, current-limited (see Chapter 12)

4 Connecting devices

This chapter describes the connection of safety sensors and actuators to the MELSEC-WS safety controller and provides configuration information for the selected functions.

The MELSEC-WS safety controller supports applications up to Performance Level (PL) e (in accordance with EN ISO 13849-1) and up to Safety Integrity Level SILCL3 (in accordance with EN 62061).

To this purpose take all the required marginal conditions and evaluate these, for example, in a failure analysis (FMEA).

For further information that has to be taken into consideration during the electrical installation, see Chapter 7.

ATTENTION

Loss of the safety function through an incorrect configuration!

- Plan and carry out configuration carefully!

The configuration of safety applications must be carried out with the greatest accuracy and must match the status and the condition of the machine or system to be monitored.

- Check whether the configured safety application monitors the machine or system as planned and whether the safety of a configured application is ensured at all times. This must be ensured in each operating mode and partial application. Document the result of this check!
- In each case, observe the instructions for commissioning and daily checking in the manuals of the protective devices integrated into the safety application!
- Note the warnings and function descriptions of protective devices connected to the MELSEC-WS safety controller! Contact the respective manufacturer of the protective device if in doubt!
- Take into account that the minimum switch-off time of the connected sensors must be greater than the execution time of the logic (see the chapter about the logic editor in the Safety Controller Setting and Monitoring Tool Operating Manual and the logic editor in the Setting and Monitoring Tool.) so that it is ensured that the MELSEC-WS safety controller can detect the switching of the sensors. The minimum switch-off time of sensors is usually specified in the technical data of the sensors.

Note If an odd-numbered test output is used, odd-numbered inputs have to be used. If an even-numbered test output is used, even-numbered inputs have to be used.

You have to use the test outputs of the module to which the device to be tested is connected.

After the configuration you obtain the following documentations in the Setting and Monitoring Tool under “Report”:

- Logic report
- Parts list
- Information on wiring

Figure 11:
Example extract of the documentation in the Setting and Monitoring Tool



Module	Type Code	Address
CPU1	WS0-CPU1	0
XTIO	WS0-XTIO	1
XTDI	WS0-XTDI	2

2.3. I/O-Module

2.3.1. XTIO - General Information

Type Code	Serial number	Version	Hardware version	Firmware version	Address
WS0-XTIO	0401 0000	1.2.0.60	0.00	V 1.00.0	1

2.3.2. XTIO - IO

Test outputs	Period value (ms)	Gap value (ms)	Long gap value (ms)
X1	200	1	-
X2	200	1	-

		Mode	Title / Tag name	ON-OFF	OFF-ON	Dis. (ms)
24V 0V	A1 A2	-	XTIO[1] Power Supply	-	-	-
X1 X2	I1 I2	NC	E-Stop, ES21 (Dual Channel)	-	-	3000
24V	I4	NO	Reset (Single Channel)	-	-	-
	Q1		Lamp (Single Channel)			-
	Q3 Q4		Motor Contactor (Dual Channel)			-

2.3.3. XTDI - General Information

Type Code	Serial number	Version	Hardware version	Firmware version	Address
WS0-XTDI	0401 0000	1.2.0.60	0.00	V 1.00.0	2

2.3.4. XTDI - IO

		Mode	Title / Tag name	ON-OFF	OFF-ON	Dis. (ms)
24V 24V	I1 I2	NC	C4000 (Safety Light Curtain, Type 4)	-	-	3000

4.1 Safety command devices and electro-mechanical safety switches

4.1.1 Emergency stop pushbuttons (e.g. SICK ES21)

Table 14: Connection of emergency stop pushbuttons

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Single-channel, without testing		Contact between 24 V and I1
Single-channel, with testing		Contact between X2 and I2
Dual-channel, without testing		Channel 1: Contact between 24 V and I3 Channel 2: Contact between 24 V and I4
Dual-channel, with testing		Channel 1: Contact between X1 and I5 Channel 2: Contact between X2 and I6

The dual-channel emergency stop pushbuttons preconfigured in the Setting and Monitoring Tool have equivalent switching contacts. Corresponding elements for implementing dual-channel antivalent switching contacts are available in the element window under the group of floating contacts.

Table 15: Functions of emergency stop pushbuttons

Function	Notes
Testing	Possible
Series connection/ cascading	Max. number of emergency stop pushbuttons connected in series: Take the max. line resistance of 100 Ω in account (see Chapter 12).
Discrepancy times	See the Safety Controller Setting and Monitoring Tool Operating Manual.

Note Further information is available in the manual of the emergency stop pushbutton, SICK ES21 or in the manuals for devices used.

4.1.2 Electro-mechanical safety switches with and without interlock (e.g. SICK I10, I100 and I1000)

Table 16: Connection of electro-mechanical safety switches

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Single-channel, without testing		Contact between 24 V and I1
Single-channel, with testing		Contact between X1 and I1
Dual-channel, without testing		Channel 1: Contact between 24 V and I3 Channel 2: Contact between 24 V and I4
Dual-channel, with testing		Channel 1: Contact between X1 and I5 Channel 2: Contact between X2 and I6

Table 17: Connection of interlocks

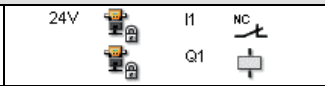
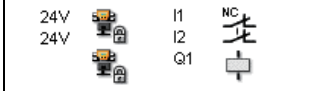
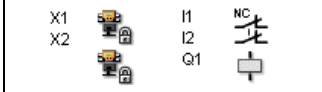
Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Single-channel, without testing		Contact between 24 V and I1 Coil at Q1
Single-channel, with testing		Contact between X2 and I2 Coil at Q2
Dual-channel, without testing		Channel 1: Contact between 24 V and I3 Channel 2: Contact between 24 V and I4 Coil at Q1
Dual-channel, with testing		Channel 1: Contact between X1 and I1 Channel 2: Contact between X2 and I2 Coil at Q1

Table 18: Functions of electro-mechanical safety switches and interlocks

Function	Notes
Testing	Possible
Series connection / Cascading	The max. number of series-connected safety switches is determined by the max. line resistance of 100 Ω see Chapter 12).
Discrepancy times	See the Safety Controller Setting and Monitoring Tool Operating Manual.

Note Further information is available in the manuals of the electro-mechanical safety switches or in the manuals of devices used.

4.1.3 Enabling switch (e.g. SICK E100)

Table 19: Connection of enabling switches

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
2 positions, without testing		Channel 1: Contact E31 between 24 V and I1 Channel 2: Contact E41 between 24 V and I2
2 positions, with testing		Channel 1: Contact E31 between X1 and I3 Channel 2: Contact E41 between X2 and I4
3 positions, without testing		Channel 1: Contact E13 between 24 V and I5 Channel 2: Contact E23 between 24 V and I6 Channel 3: Contact E31 between 24 V and I7 Channel 4: Contact E41 between 24 V and I8
3 positions, with testing		Channel 1: Contact E13 between 24 V and I1 Channel 2: Contact E23 between 24 V and I2 Channel 3: Contact E31 between X1 and I3 Channel 4: Contact E41 between X2 and I4

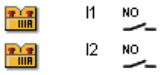
Table 20: Functions of enabling switches

Function	Notes
Testing	Possible
Series connection	Not possible
Discrepancy times	See the Safety Controller Setting and Monitoring Tool Operating Manual.

Note Further information is available in the manual of the enabling switch, SICK E100 or in the manuals of devices used.

4.1.4 Two-hand control

Table 21: Connection of two-hand control

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
I Type IIIA without testing 		Channel 1: Contact between 24 V and I1 Channel 2: Contact between X2 and I2
Type IIIC without testing 		NC contact between 24 V and I1(I3) NO contact between 24 V and I2(I4)

Type IIIA

At Type IIIA two equivalent inputs (NO contacts of the two two-hand buttons) are monitored.

A valid input signal is only generated if the ON state (H level) exists at both inputs within a period of 0.5 s (synchronous change, both two-hand buttons pressed) and if both were in the OFF state (L level) beforehand.

Type IIIC

At Type IIIC two pairs of antivalent inputs (NO/NC contact pairs of the two two-hand buttons) are monitored.

A valid input signal is only generated if the ON state (H/L level) exists at both inputs within a period of 0.5 s (synchronous change, both two-hand buttons pressed) and if both were in the OFF state (L/H level) beforehand.

Note Further information is available in the manual of the two-hand control.

4.1.5 Safety mats

Table 22: Connection of safety mats

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Pressure-sensitive short-circuiting switching mats in 4-wire technology, with testing		Channel 1: Contact between X1 and I1 Channel 2: Contact between X2 and I2

Table 23: Functions of safety mats

Function	Notes
Testing	Possible
Series connection	Possible

Note Further information is available in the manual of the safety mats.

4.1.6 Operating mode selector switch

Table 24: Connection of operating mode selector switch

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Operating mode selector switch (1 of 2) without testing		Channel 1: Contact between 24 V and I1 Channel 2: Contact between 24 V and I2
Operating mode selector switch (1 of 2) with testing		Channel 1: Contact between X1 and I1 Channel 2: Contact between X1 and I3

Table 25: Function of operating mode selector switch

Function	Notes
Testing	Possible

Note

- Untested variant operating mode selector switches can be used that allow selections between 2 and 8 operating modes, test variant switches between 2 and 4.
- When wiring the tested operating mode selector switches it should be noted that odd-numbered inputs (I1, I3, I5, I7) have to be used if an odd-numbered test output (X1, X3, X5, X7) is used, and even-numbered inputs (I2, I4, I6, I8) have to be used if an even-numbered test output (X2, X4, X6, X8) is used.
- Further information is available in the manual of the operating mode selector switch.

4.1.7 Floating contacts

The Setting and Monitoring Tool makes a series of floating contacts available for “free” configuration of contact elements. This allows different NC/NO contact combinations with and without testing to be implemented. In addition elements are available for the start and stop button, reset button and external device monitoring (EDM).

Table 26: Functions of floating contacts

Function	Notes
Testing	Possible
Series connection	Possible
Discrepancy time	See the Safety Controller Setting and Monitoring Tool Operating Manual.

4.2 Non-contact safety sensors

4.2.1 Magnetic safety switches (e.g. SICK RE)

Magnetic safety switches with equivalent inputs (e.g. SICK RE13, RE27)

Table 27: Connection of magnetic safety switches with equivalent inputs

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
With testing		Channel 1: Contact between X1 and I1 Channel 2: Contact between X2 and I2

Magnetic safety switches with complementary inputs (e.g. SICK RE11, RE21, RE31, RE300)

Table 28: Connection of magnetic safety switches with complementary inputs

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
With testing		NC contact between X1 and I1 NO contact between X2 and I2

Table 29: Functions of magnetic safety switches

Function	Notes
Testing	Possible
Series connection / Cascading	Possible; observe max. line resistance of 100 Ω and correct setting of the test impulse time.
Discrepancy time	See the Safety Controller Setting and Monitoring Tool Operating Manual.

Note Further information is available in the manuals of the SICK magnetic safety switches or in the manuals of devices used.

4.2.2 Inductive safety switches (e.g. SICK IN4000, IN40 Direct)

Table 30: Connection of inductive safety switches

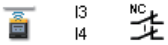
Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
IN4000		Test input TE (IN4000) at X1 Output A (IN4000) at I1
IN40 Direct (with OSSD)		OSSD1 (IN4000) at I3 OSSD2 (IN4000) at I4

Table 31: Functions of inductive safety switches

Function	Notes
Testing	Necessary on IN4000!
Series connection/ cascading	**IN40 direct** cannot be cascaded. **IN4000:** up to 6 sensors per input. Observe max. line resistance of 100 Ω and correct setting of the test impulse time.

Note Max. off-on delay through a complete chain may not exceed a maximum of 10 ms.

Further information is available in the manuals of the SICK inductive safety switches or in the manuals of devices used.

4.2.3 Transponder (e.g. SICK T4000 Compact, T40 Direct)

Table 32: Connection of transponders

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
T4000 Compact (without testing)		24 V at +LA, I1 at LA 24 V at +LB, I2 at LB
T4000 Compact (with testing)		X1 at +LA, I3 at LA X2 at +LB, I4 at LB
T40 Direct (with OSSD)		24 V at UB (T40), I5 at OA 24 V at UB (T40), I6 at OB

Table 33: Functions of transponders

Function	Notes
Testing	Possible for T4000 Compact Not necessary for T40 Direct, since self monitored.
Series connection / Cascading	T4000 Compact not cascadable; Take the max. line resistance of 100 Ω into account at the T40 (see Chapter 12).

Note For further information refer to the manuals of the Transponder SICK T4000 Compact or T40 Direct, or in the manuals of devices used.

4.3 Testable single-beam photoelectric safety switches

4.3.1 Testable Type 2 single-beam photoelectric safety switches (e.g. SICK Wx12/18/24/27)

Table 34: Connection of testable Type 2 single-beam photoelectric safety switches

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
Wx12/18/24/27, Vx18		Test input TE (transmitter) at X1 Output Q (receiver) at I1
L21/27/28		Test input TE (transmitter) at X2 Output Q (receiver) at I2

Note Route the transmitter and receiver lines outside the control cabinet in such a manner that cross-circuiting between these lines can be excluded, for example in separate sheathed cables or in protected areas.

Table 35: Functions of testable Type 2 single-beam photoelectric safety switches

Function	Notes
Testing	Possible
Series connection / Cascading	Wx12/18/24/27, Vx18: max. 5 pairs per input can be cascaded. L21: max. 35 pairs per input can be cascaded. L27/28: max. 4 pairs per input can be cascaded. Max. power-up delay of the cascade 12 ms (otherwise the test gap will lead to switching off). Take the max. line resistance of 100 Ω into account.

Note For further information refer to the manual of the testable Type 2 single-beam photoelectric safety switches.

4.3.2 Testable Type 4 single-beam photoelectric safety switches

Table 36: Connection of testable Type 4 single-beam photoelectric safety switches

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
L41		Test input TE (transmitter) at X1 Output Q (receiver) at I1

Note Route the transmitter and receiver lines outside the control cabinet in such a manner that cross-circuiting between these lines can be excluded, for example in separate sheathed cables or in protected areas.

Table 37: Functions of testable Type 4 single-beam photoelectric safety switches

Function	Notes
Testing	Necessary
Series connection / Cascading	Max. 10 pairs per input Max. power-up delay of the cascade 12 ms (otherwise the test gap will lead to switching off) Take the max. line resistance of 100 Ω into account

Note For further information refer to the manual of the testable Type 4 single-beam photoelectric safety switches.

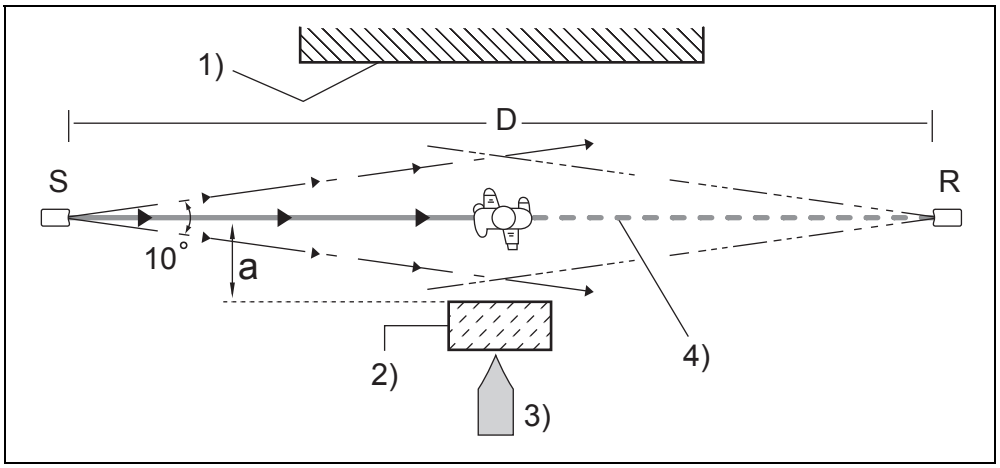
4.3.3 Information for mounting testable single-beam photoelectric safety switches

Note Observe the information for mounting in the manuals of the respective sensors and in particular the following points:

- Single-beam photoelectric safety switches may only be used as access protection in accordance with EN 999[*1]. Usage as finger and hand protection is not permissible.
- Observe the minimum distance to reflective surfaces.
- It is imperative that the safety distance between the light beam and hazardous point be observed at access protection.

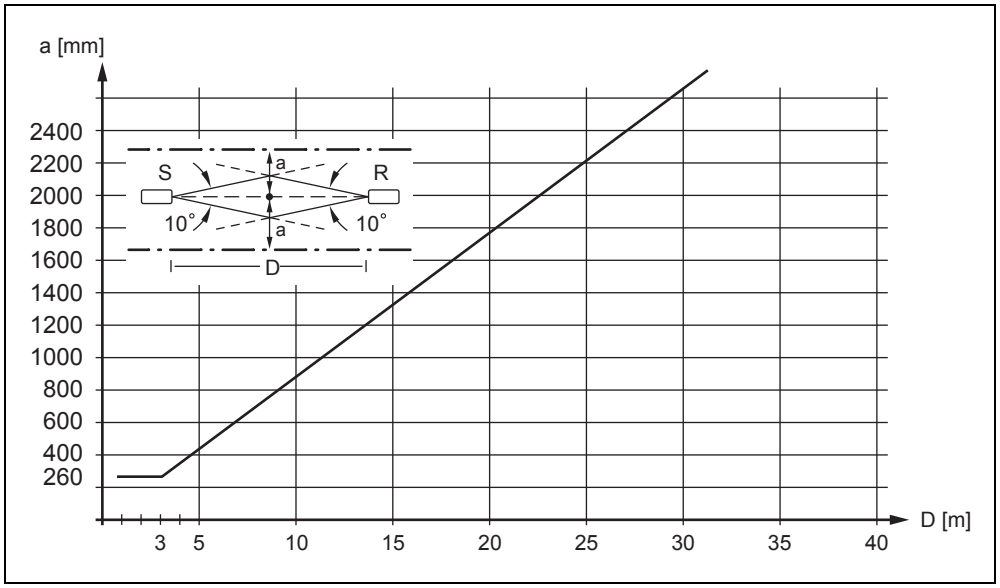
*1 In the future EN ISO 13855.

Figure 12:
Minimum distance “a” to reflective surfaces, correct mounting and alignment



S = Sender
R = Receiver
D = Distance between sender and receiver
1 = Limit to hazardous area
2 = Reflective surface
3 = Direction of access to hazardous area
4 = Optical axis
a = Minimum distance from reflective surfaces

Figure 13:
Minimum distance “a” as a factor of the distance “D” for testable single-beam photoelectric safety switches with a field of view of 10° (e.g. SICK Wx12/18/24/27, Vx18)

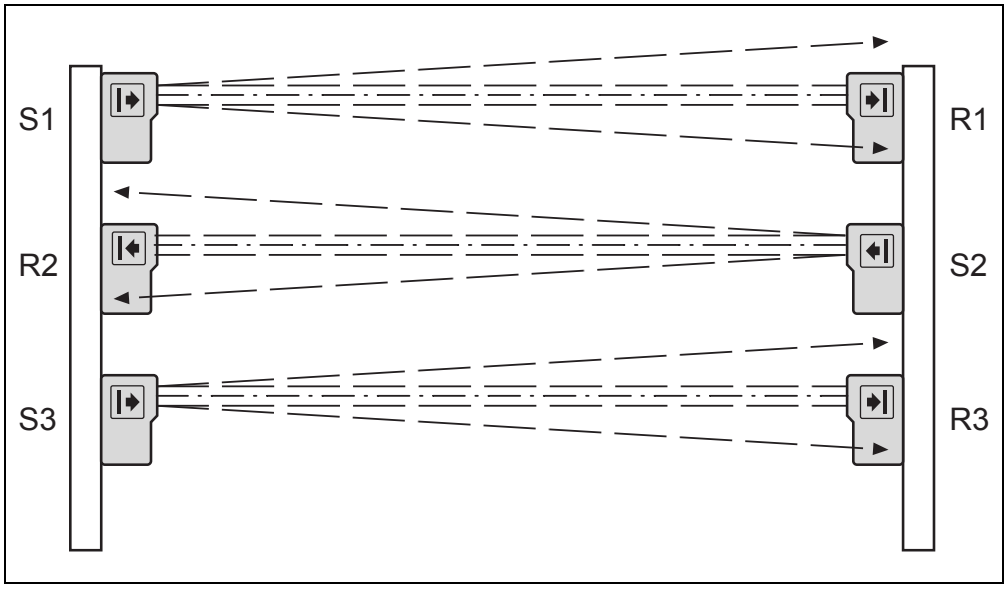


Note Diagrams for L21 and L41 are available in the respective manuals.

Avoiding mutual influence at single-beam photoelectric safety switches and between cascades

- If several single-beam photoelectric safety switch pairs are used, the field of view of the sensors has to be observed in order to prevent mutual influence.
- If the senders are only mounted on one side, the light beams may not overlap on the receiver side so that the light beam of one sender does not reach two receivers.
- If the senders and receivers are mounted alternatively, ensure that the light beam of Sender S1 cannot be received by Receiver R3 and that the light beam of Sender S3 cannot be received by Receiver R1.

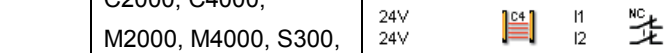
Figure 14:
Mounting to avoid mutual optical influence



4.4 Electro-sensitive protective equipment (ESPE)

(e.g. SICK C2000/C4000/M2000/M4000/S300/S3000/V300)

Table 38:
Connection of ESPE

Electrical connection: Example from Setting and Monitoring Tool with WS0-XTIO		
C2000, C4000, M2000, M4000, S300, S3000, V300		OSSD1 (receiver) at I1 OSSD2 (receiver) at I2

Note Further information is available in the manual of the corresponding SICK ESPE or in the manuals of devices used.

4.5 Outputs

ATTENTION

Safety-oriented devices must be suitable for safety related signals!

A function interruption of safety outputs results in a loss of the safety functions so that the risk of serious injury exists.

- Do not connect any loads that exceed the rated values of the safety outputs.
- Wire the MELSEC-WS safety controller so that 24 V DC signals cannot unintentionally contact safety outputs.
- Connect the GND wires of the power supply to earth so that the devices do not switch on when the safety output line is applied to frame potential.
- Use suitable components or devices that fulfil all the applicable regulations and standards.

Actuators at the outputs can be wired single-channeled. In order to maintain the respective Safety Integrity Level the lines have to be routed in such a manner that cross circuits to other live signals can be excluded, for example by routing them within protected areas such as in a control cabinet or in separate sheathed cables.

4.6 EFI devices

If shielding is required, for example for EMC reasons, when connecting the EFI devices, use an earth terminal that is placed in the control cabinet near the CPU module for this purpose. Connect this earth terminal with the shielding.

Note

- No termination is required for unused EFI connections on the CPU.
- The CPU and the connected EFI devices should be powered by the same voltage supply to ensure a simultaneous start-up of all devices.
- You will find information on connecting EFI devices incl. pin assignments in the manuals for the corresponding devices.

4.6.1 EFI communication and EMC

Cables

Mitsubishi offers a 5-wire cable and a 12-wire cable for the connection of EFI devices.

The 5-wire cable has a high EMC rating and can be used up to a length of 100 m. The 5 wires are typically used for the EFI1, EFI2, 24 V DC, 0 V DC contacts and for the functional earth.

If more wires are required to exchange additional signals between sensor and controller, 12-wire cables are available. These can be used up to a length of 50m.

Connecting the EFI cable to FE

To increase the EMC resistance of the bus communication, it is important to connect the EFI cable screen on one or both sides to functional earth.

Connect this screen to the same DIN rail to which the functional earth (FE) of the MELSEC-WS safety controller is connected in order to minimize interferences on the EFI cable. The connection of the screen to FE should be close to the cable inlet of the control cabinet.

Note

- The FE terminal of the MELSEC-WS safety controller is located at the bottom of the housing and connects automatically to the DIN rail when the module is mounted.
- To avoid further interferences, the functional earth of the SICK sensors (e.g. M4000, S3000) must be connected to the EFI screen as well.
- If other cables are present within the same cable duct where the EFI cable is routed and these cables emit a high degree of EMC interference (drives or motor related), this can lead to availability problems in the application. In this case, it is recommended to install the EFI cable in a separate duct.

5 Special functions

5.1 Enhanced Function Interface - EFI

The WS0-CPU1 module has 2 EFI interfaces. This chapter describes the properties, the functions and the benefits of these interfaces.

The general EFI function description and the possibilities for combining SICK products with regard to EFI are available in the corresponding manuals of SICK products.

5.1.1 Definition

An EFI interface is a safe communication interface between SICK devices. With it information from the sensor equipment can be read out, as well as commands transferred to the sensor equipment.

5.1.2 Properties

- Up to 4 SICK devices are possible per EFI line, in as far as the EFI-compatible devices support this number.
- Connection of the devices using a 2-wire cable
- Various device combination possibilities
  Sensor with sensor within the same product family
  Sensor with safety controllers and network modules
- Transferring of status information between SICK devices using an EFI interface
- Activation/utilisation of sensor functions

5.1.3 Functions

In addition to the product-specific functions of the respective EFI-compatible devices the following functions are available:

General functions

- **Status information** of the sensors are available in the MELSEC-WS safety controller and at the sensor
- **Diagnostics information** of all the EFI nodes is available in the MELSEC-WS safety controller
- Transfer of configuration information

Special functions

- Simultaneous protective field evaluation
- Protective field switching
- Function changeover
- Operating mode selection
- Signal routing
- Decentralized diagnostics information via Ethernet
- Information on the location of the protective field interruption at host-guest applications
- Evaluation of signals and forwarding of the results

5.1.4 Benefits

- **Reduction of the installation work** (only 2 wires) when signals from several sensors are used
- **Reduction of the required material** through possibility of saving function blocks and I/Os
- **High availability** through provision of the diagnostics information with high information contents for rapid and correct handling options

5.2 Muting

5.2.1 General description

Muting is the automatic temporary bypassing of all the safety-oriented functions of the control system or of the safety device. Muting is used when certain objects, such as pallets with material, may be moved into the hazardous area. During this transportation through electro-sensitive protective equipment (ESPE), such as a safety light curtain, the muting function suppresses monitoring by the ESPE.

Observe the information in the Safety Controller Setting and Monitoring Tool Operating Manual for the further procedure.

5.2.2 SICK muting sensors

Table 39: Selection of the SICK optical muting sensors

Sensor	Type	Switching output Q
Photoelectric proximity switch	WT24	Light switching
	WT27-2	
	WT260	Light switching
Photoelectric reflex switch	WL23	Dark switching
	WL27	
	WL260	Dark switching
	WL12	Dark switching
	WL14	Dark switching
	WL18-2	Dark switching
Through-beam photoelectric switch	WS24/WE24	Dark switching
	WS27/WE27	
	WS260/WE260	

6 Mounting/Dismantling

This chapter describes the mounting of the modules of the MELSEC-WS safety controller.

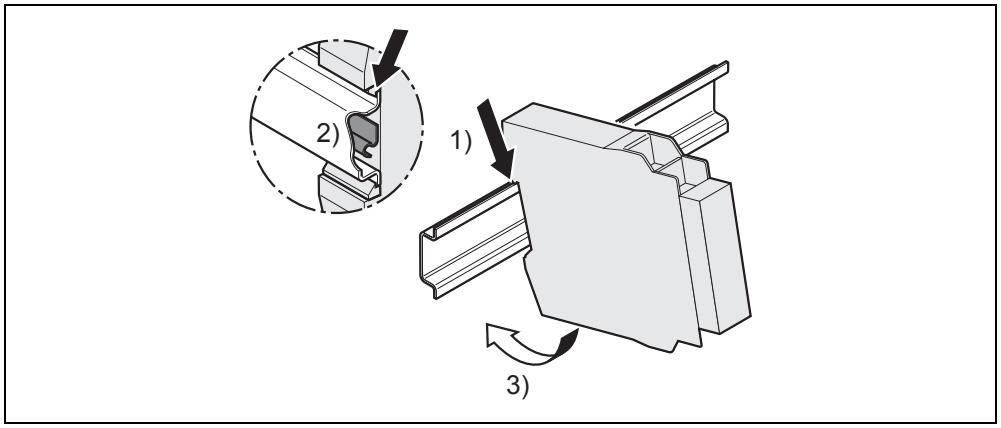
6.1 Steps for mounting the modules

ATTENTION

The MELSEC-WS safety controller is only suitable for mounting in a control cabinet with at least IP 54 degree of protection.
While supply voltage is applied, modules must not be plugged to nor be removed from the MELSEC-WS safety controller.
To ensure full electromagnetic compatibility (EMC), the DIN mounting rail must be connected to functional earth (FE).

- In a MELSEC-WS safety controller, the WS0-CPU0 or WS0-CPU1 module is positioned at the extreme left.
- The two optional network modules follow directly to the right of the CPU module.
- Connect further MELSEC-WS safety I/O modules (e.g. WS0-XTIO or WS0-XTDI) onto the right side of the network modules and any additional safety relay output modules (WS0-4RO) to the extreme right of the entire MELSEC-WS safety controller.
- Ensure that suitable ESD protective measures are also taken during mounting. Otherwise the FLEXBUS+ backplane bus may be damaged.
- The connection between the modules is effected by means of the plug connection integrated in the housing. Take into account that, when replacing a module, the MELSEC-WS modules have to be pushed approx. 10 mm apart before the corresponding module can be removed from the DIN rail.
- Take suitable measures to ensure that foreign matter does not penetrate the connector openings, in particular that of the memory plug.
- Mounting in accordance with EN 50274
- The modules are located in a 22.5 mm wide modular system for 35 mm DIN rails to EN 60715.

Figure 15:
Mounting the module onto the DIN rail



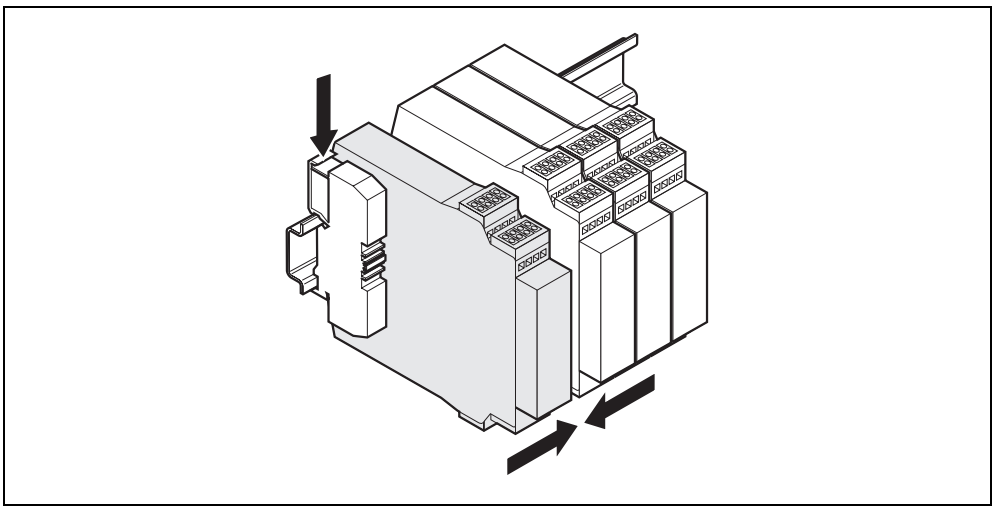
⇒ Make sure that the voltage supply of the MELSEC-WS safety controller is switched off.

⇒ Hang the device onto the DIN rail (1)).

⇒ Ensure that the earthing spring contact is positioned correctly (2)). The earthing spring contact of the module must contact the DIN rail securely to allow electrical conductivity.

⇒ Latch the module onto the DIN rail by pressing it lightly in the direction of the arrow (3)).

Figure 16:
Installing the end clips



⇒ If there are several modules, slide the modules together individually in the direction of the arrow until the side plug connection latches in.

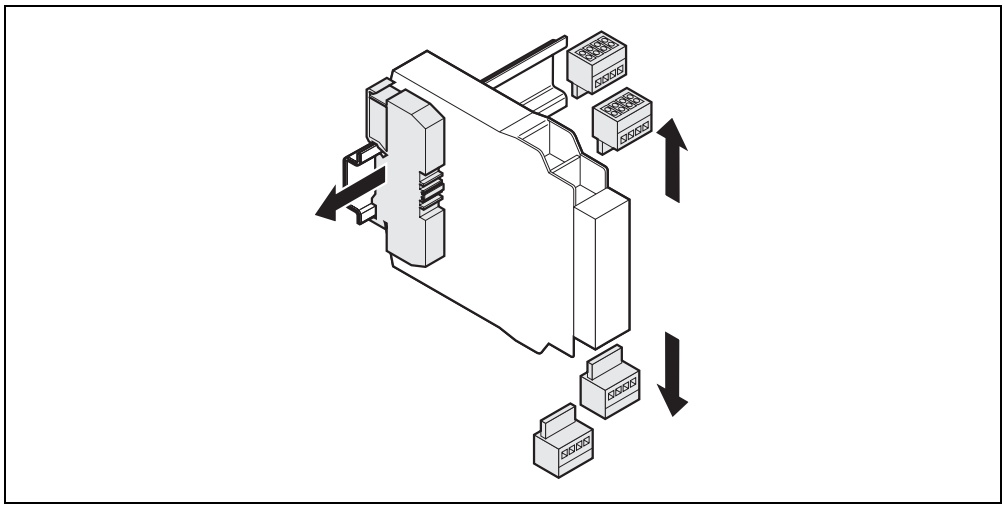
⇒ Install the end clips on the right and left.

The following steps are necessary after mounting:

- Completing the electrical connections
- Configuration (See the Safety Controller Setting and Monitoring Tool Operating Manual.)
- Checking the installation

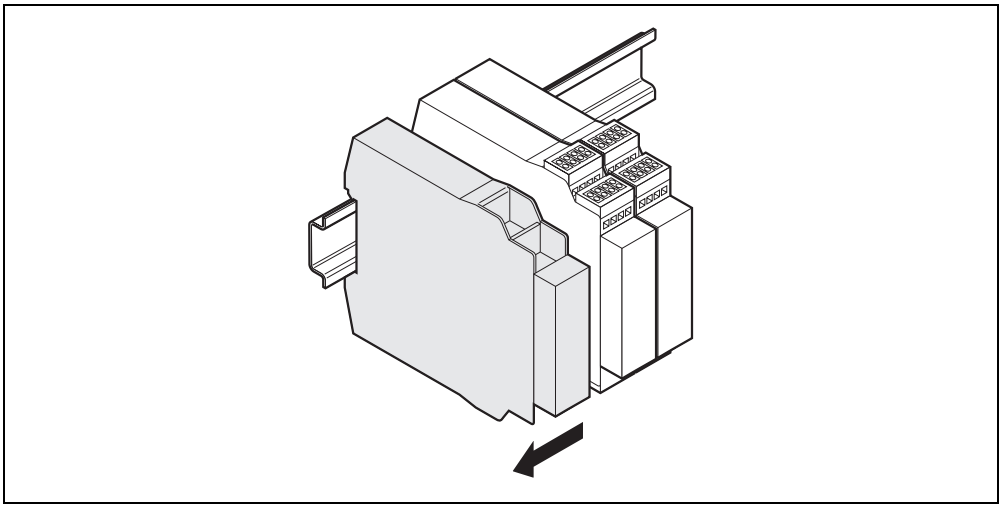
6.2 Steps for dismantling the modules

Figure 17:
Removing the removable terminals



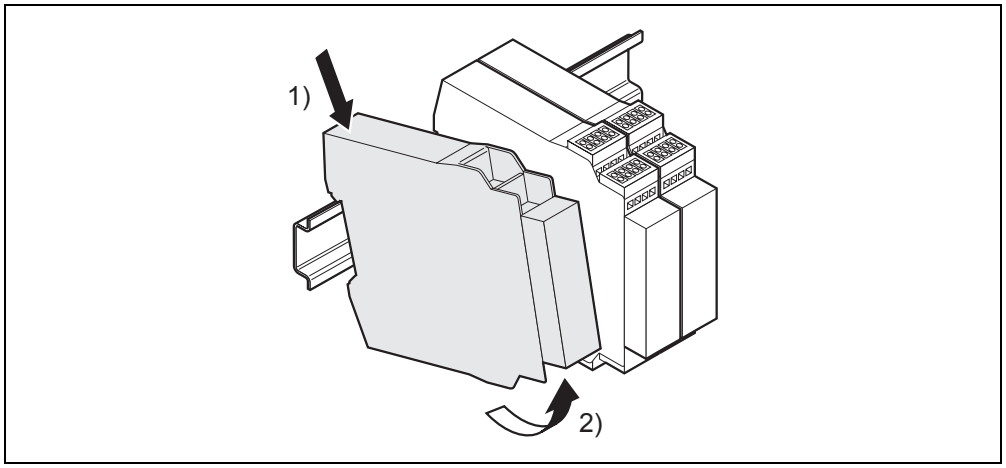
⇒ Remove the removable terminals with wiring and the end clips.

Figure 18:
Disconnecting the plug connections



⇒ If there are several modules, slide the modules away from each other individually in the direction of the arrow until the side plug connection is separated.

Figure 19:
Removing modules from the DIN rail



⇒ Press the module downwards at the rear (1)) and remove it from the DIN rail in the direction of the arrow while keeping it pressed down (2)).

7 Electrical installation

ATTENTION

Switch the entire machine/system off line!
The system could start up unexpectedly while you are connecting the devices.

Note

- The MELSEC-WS safety controller fulfils the EMC requirements in accordance with the basic specification EN 61000-6-2 for industrial use.
- To ensure full electromagnetic compatibility (EMC), the DIN mounting rail has to be connected to functional earth (FE).
- The control cabinet or assembly casing of the MELSEC-WS safety controller must comply at least with enclosure rating IP 54.
- Mounting in accordance with EN 50274
- Electrical installation in accordance with EN 60204-1
- The voltage supply of the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204-1.
- The voltage supply has to fulfil the regulations for extra-low voltages with safe separation (SELV, PELV) in accordance with EN 60664 and DIN 50178 (equipment of electrical power installation with electronic devices).
- All connected pick-ups and downstream controllers as well as wiring and installation must correspond to the required category in accordance with EN 954-1[*1], EN ISO 13849-1 and in accordance with SIL3 to EN 62061 and conform to the required safety level in accordance with EN 954-1[*1], EN 62061 or EN ISO 13849-1. For further information refer to Chapter 12.

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

- Ensure that all the modules of the MELSEC-WS safety controller, the connected protective devices as well as the voltage supply/ies are connected with the same earth (GND). The GND of the RS-232 interface is connected internally to the GND of the supply of the CPU module (A2).
- If the RS-232 interface at the CPU module is used as an alternative to a network module, observe the limitation of the cable length (max. 3 m). In addition, the line at least has to be connected to the CPU module and earthed in the control cabinet in which the CPU module is connected.
- Route the lines outside the control cabinet in such a manner that cross-circuiting between these lines can be excluded, e.g. in separate sheathed cables or in protected areas.
- In order to protect the safety outputs and to increase the service life, the external loads have to be equipped with, for example, varistors or RC elements. Take into account that the response times may increase, depending on the type of protective circuiting.
- The safety outputs and the contactor monitoring (EDM) have to be wired inside the control cabinet.
- If a module is replaced the terminal assignment has to be guaranteed, for example by labelling or corresponding cable routing.

- Mount the reset button so that it cannot be actuated by a person located in the hazardous area. When operating the control device of the reset button, the operator must have full visual command of the hazardous area.
- Between the supply circuit and output circuit, and between the input circuit and output circuit in the WS0-4RO module are isolated. On the other hand, those in the safety I/O module are not isolated.



ATTENTION

Limited short-circuit recognition!
A WS0-XTDI module has two test signal generators. One test signal generator is responsible for the odd-numbered test outputs X1, X3, X5 and X7, the other for the even-numbered test outputs X2, X4, X6 and X8.

Note This means that short-circuits between odd-numbered and even-numbered test outputs are recognised when the test gaps < 4 ms. If the test gaps ≥ 4 ms, the short-circuits are not always recognised in every case. Similarly short-circuits amongst the even-numbered test outputs and odd-numbered test outputs are not recognised, Take this into consideration during the wiring (e.g. separate routing, sheathed cables)!

8 Configuration

ATTENTION

Check the configuration for the protective device before commissioning and after every change!
If you change the configuration, you must check the effectiveness of the protective device. Please observe the test notes in the manual of the connected protective device.

Note The Setting and Monitoring Tool and the WS0-MPL memory plug are required to configure the MELSEC-WS safety controller.

Configuration and verification of devices that are connected to the safety controller is generally not carried out by using the Setting and Monitoring Tool, even if they can be addressed via an RS-232 interface of a MELSEC-WS module. These devices have their own mechanisms for configuration and verification. The exception is formed by the EFI sensors connected to the WS0-CPU1 module (EFI elements from the elements window). These sensors can be configured directly in the Setting and Monitoring Tool by double-clicking the icon, or alternatively configured and verified locally at the sensor via the RS-232 interface. The SICK configuration and diagnostics software CDS is used to this purpose.

- The SICK configuration and diagnostics software CDS included in Setting and Monitoring Tool is the product of SICK. For the CDS, please contact your local SICK representative (see Annex, Section 14.5).
  http://www.sens-control.com
- The system configuration of the complete MELSEC-WS module (with the exception of the EFI-compatible devices) is only stored in the memory plug. This offers the advantage when terminal modules are replaced that the system does not have to be reconfigured.
- The data stored in the memory plug are retained when the voltage supply is interrupted.
- Transfer of **configuration information** via the EFI interface possible.

9 Commissioning

ATTENTION

Do not commission without a check by qualified safety personnel!
Before initial commissioning of a system using a MELSEC-WS safety controller, it must be checked and released by qualified safety personnel.

ATTENTION

Check the hazardous area!

- Ensure that no one is located in the hazardous area before commissioning.
- Check the hazardous area and secure it against being entered by people (e.g. set up warning signs, attach blocking ropes or similar). Observe the relevant laws and local regulations.

9.1 Full approval of the application

System commission may only be carried out if full approval was successful. Full approval may only be performed by professionals trained accordingly.

The full approval includes the following items to be checked:

⇒ Check whether the attachment of components to the connections corresponds to the required Safety Integrity Level in accordance with EN 954-1[*1] or EN 62061 and/or EN ISO 13849-1.

⇒ Check the devices connected to the safety controller in accordance with the test notes from the accompanying manual.

⇒ Clearly mark all the connection cables and plugs at the safety controller in order to avoid confusion. Since the MELSEC-WS safety controller has several connections of the same design, ensure that loosened connection cables are not connected back to the wrong connection.

⇒ Check the signal paths and the correct inclusion in higher-level controllers.

⇒ Check the correct data transfer from and to the MELSEC-WS safety controller.

⇒ Check the logic program of the safety controller.

⇒ Perform a complete validation of the safety functions of the system in each operating mode and an error simulation. Observe the response times of the individual applications in particular.

⇒ Completely document the configuration of the system, the individual devices and the result of the safety check.

⇒ In order to prevent unintentional overwriting of the configuration, activate the write protection of the configuration parameters of the MELSEC-WS safety controller. Modifications are only possible if the write protection has been deactivated.

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

9.2 Tests before the initial commissioning

A report that provides the configuration can be created with the Setting and Monitoring Tool.

The purpose of the initial commissioning tests is to confirm the safety requirements specified in the national/international rules and regulations, especially in the Machine and Work Equipment Directive (EC Conformity).

⇒ Check the effectiveness of the protective device at the machine, using all the selectable operating modes and functions.

⇒ Ensure that the operating personnel of the machine fitted with the MELSEC-WS safety controller become instructed by the qualified safety personnel of the machine owner before beginning work. Arranging the instruction is the responsibility of the machine owner.

10 Diagnostics

10.1 In the event of faults or errors

ATTENTION

Cease operation if the cause of the malfunction has not been clearly identified!
Stop the machine if you cannot clearly identify or allocate the error and if you cannot safely remedy the malfunction.
Complete functional test after remedying malfunction!
Carry out a full functional test after a malfunction has been remedied.

ERROR operating mode

With certain malfunctions or a faulty configuration, the MELSEC-WS safety controller enters the safe status. The MS and CV LEDs of the individual modules of the safety controller indicate the corresponding type of error.

To place the device back in operation:

⇒ Rectify the cause of the malfunction in accordance with the display of the MS and CV LEDs.
⇒ Switch the voltage supply of the safety controller off and back on again.

The MELSEC-WS safety controller may restart when it detects a recoverable error caused by noise.

The MELSEC-WS safety controller is ready for operation again if the error cause has been eliminated after the restart.

Create an interlock program using a reset button to prevent the MELSEC-WS safety controller from restarting automatically after the safety function is activated and the safety controller turns off the outputs.

10.2 Mitsubishi support

If you cannot remedy a malfunction using the information in this chapter, please contact your local Mitsubishi representative.

Note When you send in a WS0-MPL memory plug for repair or analysis, it is returned in the state of delivery. Therefore store the configuration(s) of your devices in the Setting and Monitoring Tool.

10.3 Error display of the MS and CV status LEDs

Error displays and error elimination are described in the individual modules, see Section 3.4 to 3.8.

10.4 Additional error displays of EFI-compatible devices

EFI-compatible devices (see Section 5.1) have extended functions in connection with the WS0-CPU1 module.

Error displays and error elimination are described in the manuals of the corresponding devices.

10.5 Extended diagnostics

The Setting and Monitoring Tool contains extended diagnostic possibilities. If you cannot identify what kind of error is occurring or if you have serviceability problems, it allows you to locate the error more accurately.

For detailed information refer to the Safety Controller Setting and Monitoring Tool Operating Manual.

11 Maintenance

The following sections inform about regular tests and the exchange of MELSEC-WS modules. Do not try to dismantle, repair or modify the MELSEC-WS modules. This can lead to a loss of the safety function(s). In addition Mitsubishi accepts no claims for liability.

11.1 Regular inspection of the protective device by qualified safety personnel

⇒ Check the system at the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes on the machine or manipulations of the protective device are detected before use/re-use.

⇒ Each safety application must be checked at an interval specified by you. The effectiveness of the protective device must be checked by authorised commissioned persons.

⇒ If any modifications have been made to the machine or the protective device, or if the MELSEC-WS safety controller has been changed or repaired, the system must be checked again as specified in the checklist in the annex.

⇒ Carry out regular or daily inspections in order to keep the MELSEC-WS safety controller modules in an optimal operating mode.

⇒ Check whether the implementation of the MELSEC-WS safety controller modules fulfills all the technical data of the device.

⇒ Check the mounting conditions and whether the wiring of the MELSEC-WS safety controller modules has been carried out correctly

⇒ Regularly verify that the safety functions fulfil the requirements of the application as well as all the regulations and standards (e.g. regular checking) in order to ensure the reliability of the safety functions.

11.2 Device replacement

A fault in the MELSEC-WS safety controller modules impairs the complete network. Devices that have faults must therefore be repaired or replaced rapidly. We recommend keeping spare devices of the MELSEC-WS safety controller at hand so that network operation can be re-established as fast as possible.

Safety measures for replacing devices

Observe the following safety measures when replacing the MELSEC-WS modules:

- Do not try to dismantle or repair the MELSEC-WS safety controller modules. Not only does Mitsubishi accept no claims for liability, but it is also dangerous because checking of the original safety functions is not possible in this case.
- Reset the device into a state in which safety is ensured.
- Carry out replacement only when the voltage supply is switched off in order to avoid an electric shock or unexpected device behaviour.
- In order to continue using the system configuration check:
  Whether the new module is of the same type (same material number) and whether there is no error at the new module after the replacement and
  That the new module is plugged at the same position as the replaced module.
- Otherwise you have to completely reconfigure and commission the new system, including all the necessary tests (see Chapter 9).

Note EFI-compatible devices have to be reconfigured after the replacement.

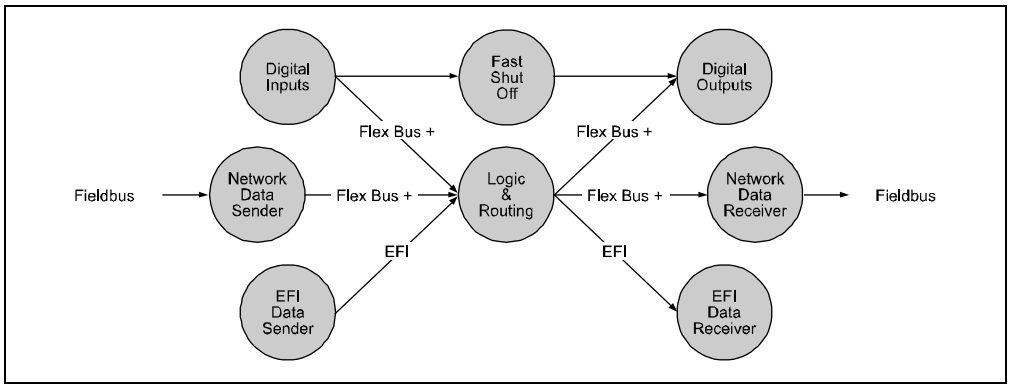
- After the replacement ensure that no errors arise with the new MELSEC-WS modules.
- Always carry out a function test before commissioning a replacement module.
- If you send in modules for repair, enclose a brief detailed description of the problem with the device and send the modules to your local Mitsubishi representative.

12 Technical data

12.1 Response times of the MELSEC-WS safety controller

In order to calculate the response times of a MELSEC-WS safety controller, all paths have to be taken into consideration.

Figure 20: Response times within a MELSEC-WS safety controller



Fast Shut Off

The Fast Shut Off function can be realised on a single WS0-XTIO module. A response time of 8 ms can be reached this way.

Note

- The Fast Shut Off function has only an effect on the inputs and outputs of the same WS0-XTIO module.
- The Fast Shut Off function can not be combined with additional function blocks. For more information see the Safety Controller Setting and Monitoring Tool Operating Manual.

Calculation of the response times

The following table can be used to calculate the response times of corresponding paths within the MELSEC-WS safety controller.

Table 40: Calculation of the response times of the MELSEC-WS safety controller in ms

Occurrence	Digital inputs	
General	Response time of the sensor[*1]	
General	Input processing time	6.5
When On/Off filter	8.0 ms	
When X1 to X8 is connected at the test output a) Safety mats and switching rails b) Testable sensors Type 4 (e.g. L41) c) All other sensors only when the gap value of the test output > 1 ms	 Period value[*2] of the test output Period value[*2] of the test output 12 ms + gap value of the test output[*2]	
	Total E1	

Occurrence	EFI message transmitter	
If EFI functions are used via EFI-compatible devices	Response time of the EFI data source (as a rule a sensor) for external OSSDs via EFI[*1]	
	Constant: a) Scanner (e.g. S300, S3000): 3.5 ms b) Light grid (e.g. C4000, M4000): 1.5 ms	
	Total E2	

Occurrence	Data from the network	
General	Response time field bus sender[*1]	
General	2 × cycle time field bus	
General	2 × update rate for data from the network[*2]	
If 1 network module	– 3 ms	
If 2 network modules	– 7 ms	
If WS0-GETH	+ 8 ms	
	Total E3	

Logic

Digital outputs	
Response time of the actuator	
Output processing time	4.5
Total A1	

EFI message receiver	
Response time of the message receiver (e.g. scanner with protective field switching via EFI)[*1]	
EFI cycle time of the EFI receiver[*1] Constant: a) Scanner (e.g. S300, S3000): 24 ms b) Light grid (e.g. C4000, M4000): 2.5 ms	
Total A2	

Logic

Data to the network	
Response time field bus receiver[*1]	
2 × cycle time field bus	
2 × update rate for data to the network[*2]	
0 ms	
– 4 ms	
+ 8 ms	
Total A3	

Evaluation		
Response time of the considered input in the signal path	E1 or E2 or E3 (from above table)	
Response time of logic	2 × logic execution time[*2]	
	Delay through logic application[*3] (e.g. On- or Off-delay function block)	
Response time of the considered output in the signal path	A1 or A2 or A3 (from above table)	
Total response time		

*1 Take values from the corresponding manual.

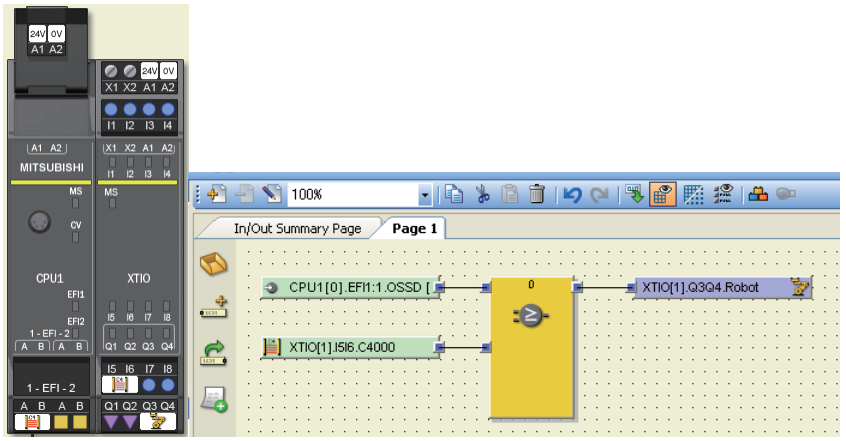
[*]2 The update rate between the CPU and a network module depends on the amount of data to be transferred and the number of network module used in the system. Take the values from the report in the Setting and Monitoring Tool.

[*]3 Time values have a tolerance of 10 ms, i.e. for each selected value 10 ms must be considered additionally for the response time. E.g. for a 10 ms Off delay, 20 ms must be used for the calculation.

Example

Calculation of the response time for a MELSEC-WS safety controller consisting of a WS0-CPU1 and a WS0-XTIO

Figure 21:
Example of a MELSEC-WS safety controller



Digital inputs:	XTIO[1].I5I6.C4000: One C4000 safety light curtain
Digital outputs:	XTIO[1].Q3Q4.Robot: Robot, dual-channel
EFI message transmitter:	[EFI 1.1] OSSD [OSS: One C4000 receiver (stand-alone) (safety light curtain with high resolution for hazardous point, hazardous area and access protection at machines)

2 paths have to be considered and calculated separately:

Figure 22:
Response times within a MELSEC-WS safety controller

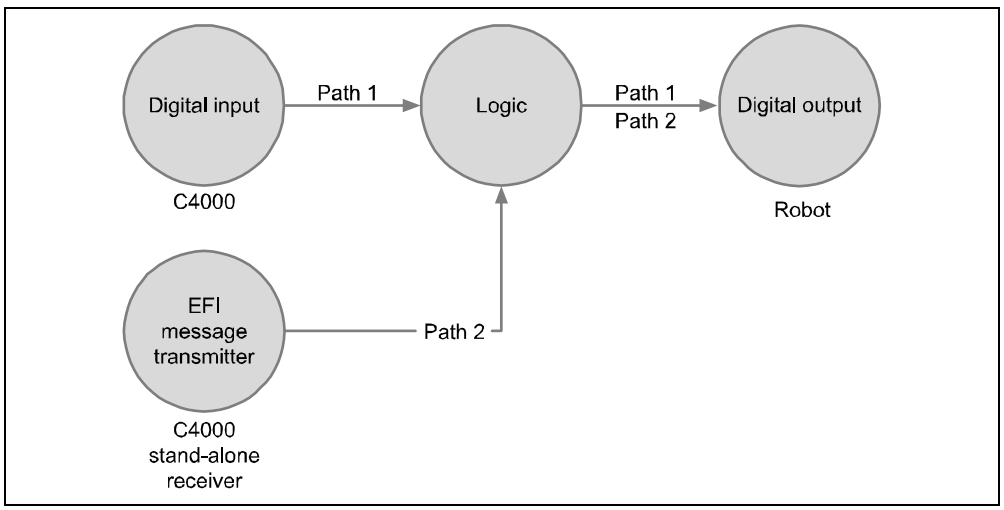


Table 41: Example for the calculation of the response time of Path 1 of a MELSEC-WS safety controller

Occurrence	Digital inputs		Logic	Digital outputs	
General	C4000 response time	14.0 ms		Robot response time	40.0 ms
General	Input processing time	6.5 ms		Output processing time	4.5 ms
When On/Off filter	8.0 ms	–			
When X1 to X8 is connected at the test output a) Safety mats and switching rails b) Testable sensors Type 4 (e.g. L41) c) All other sensors	– – –	–			
	Total E1	**20.5 ms**		**Total A1**	**44.5 ms**

Evaluation		
Response time of the considered input in Path 1	E1	**20.5 ms**
Response time of logic	2 x logic execution time	**8.0 ms**
	Delay through logic application	**–**
Response time of the considered output in Path 1	A1	**44.5 ms**
Total response time		**73.0 ms**

Table 42: Example for the calculation of the response time of Path 2 of a MELSEC-WS safety controller

Occurrence	Message transmitter		Logic	Digital outputs	
If EFI functions are used via EFI-compatible devices	Response time of the EFI data source (C4000 receiver (stand-alone))	12.0 ms		Robot response time	40.0 ms
	Constant (C4000)	1.5 ms		Output processing time	4.5 ms
	Total E2	**13.5 ms**		**Total A2**	**44.5 ms**

Evaluation		
Response time of the considered input in Path 2	E2	**13.5 ms**
Response time of logic	2 × logic execution time	**8.0 ms**
	Delay through logic application	**–**
Response time of the considered output in Path 2	A2	**44.5 ms**
Total response time		**66.0 ms**

12.2 Data sheet

12.2.1 WS0-CPU0 and WS0-CPU1 modules

Table 43:
Data sheet WS0-CPU0 and WS0-CPU1

	WS0-CPU0	WS0-CPU1
Category to EN ISO 13849-1	Category 4	
Category to EN954-1[*1]	Category 4	
Safety Integrity Level	SIL3 (IEC 61508), SILCL3 (EN 62061)	
Performance Level	PL e (EN ISO 13849-1)	
PFHd	1.07E-09 1/h	1.69E-09 1/h
TM service life	20 years	
Ambient temperature in operation	-25 °C to +55 °C	
Storage temperature	-25 °C to +70 °C	
Humidity	10% to 95%, non-condensing	
Climatic conditions	To EN 61131-2 (55 °C, 95% rel. Humidity), No corrosive gases	
Rigidity	5 Hz to 500 Hz, tested to EN 61131-2	
Enclosure rating to EN/IEC 60529	Terminals: IP 20 Housing: IP 40	
Electromagnetic compatibility	EN 61000-6-2, EN 55011 (Class A)	
Protection class	III	
Number of EFI interfaces	0	2
Data interface	Internal bus (FLEXBUS+ backplane bus)	
Configuration interface	RS-232	
Cross-circuit of connecting wires	Single-core or finely stranded: 1 x 0.14 to 2.5 mm^2 or 2 x 0.14 to 0.75 mm^2 Finely stranded with ferrules to EN 46228: 1 x 0.25 to 2.5 mm^2 or 2 x 0.25 to 0.5 mm^2	
EFI connection method	–	Two-tier spring terminals
Dimensions (W x H x D)	22.5 x 96.5 x 120.8 mm	22.5 x 101.7 x 120.8 mm
Weight	100 g	110 g

Power supply (A1, A2) via memory plug WS0-MPL

Supply voltage	24 V DC (16.8 to 30 V DC)
Type of supply voltage	PELV or SELV The current of the power supply unit that supplies the CPU module has to be limited to a maximum of 4 A - either by the power supply unit itself or by a fuse.
Power consumption	Max. 2.5 W
Switch-on time	Max. 18 s
Short-circuit protection	4 A gG (with tripping characteristic B or C)

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

12.2.2 WS0-XTIO safety input/output combined module

Table 44:
Data sheet WS0-XTIO

Category	Category 4 (EN ISO 13849-1) Category 4 (EN 954-1[*1])
Safety Integrity Level	SIL3 (IEC 61508)
Performance Level	PL e (EN ISO 13849-1)
PFHd	0.9E-09 1/h (double channel) 4.8E-09 1/h (single channel)
TM service life	20 years
Ambient temperature in operation	-25 °C to +55 °C
Storage temperature	-25 °C to +70 °C
Humidity	10% to 95%, non-condensing
Climatic conditions	to EN 61131-2 (55 °C, 95% rel. humidity), No corrosive gases
Rigidity	5 Hz to 500 Hz, tested to EN 61131-2
Enclosure rating to EN/IEC 60529	Terminals: IP 20 Housing: IP 40
Electromagnetic compatibility	EN 61000-6-2, EN 55011 (Class A)
Protection class	III
Power input via FLEXBUS+ without currents to X1, X2	Max. 1.1 W
Cross-circuit of connecting wires	Single-core or finely stranded: 1 × 0.14 to 2.5 mm^2 or 2 × 0.14 to 0.75 mm^2 Finely stranded with ferrules to EN 46228: 1 × 0.25 to 2.5 mm^2 or 2 × 0.25 to 0.5 mm^2
Data interface	Internal bus (FLEXBUS+)
Dimensions (W × H × D)	22.5 × 106.5 × 120.8 mm
Weight	180 g

Power supply unit (A1, A2)

Supply voltage	24 V DC (16.8 V DC to 30 V DC)
Type of supply voltage	PELV or SELV The current of the power supply unit that supplies the CPU module has to be limited to a maximum of 4 A - either by the power supply unit itself or by a fuse.
Power consumption	Max. 96 W, determined by the load at the outputs Q1 to Q4
Switch-on time	Max. 18 s
Short-circuit protection	4 A gG (with tripping characteristic B or C)

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

Input circuit (I1 to I8)

Input voltage HIGH	13 V DC to 30 V DC
Input voltage LOW	-5 V DC to +5 V DC
Input current HIGH	2.4 mA to 3.8 mA
Input current LOW	-2.5 mA to 2.1 mA
Switching current (with mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Discrepancy times	4 ms to 30 s, configurable
Number of inputs	8

Test outputs (X1, X2)

Number of outputs	2 (with 2 test pulse generators)
Output type	PNP semiconductor, short-circuit protected, cross circuit monitoring
Output voltage	16 V DC to 30 V DC
Output current	Max. 120 mA at a test output (X1 or X2) This means that a maximum of 8 testable sensor cascades per module with max. 30 mA each are possible. The total current of the MELSEC-WS safety controllers is limited to a maximum of 1.28 A. This corresponds to e.g. 32 inputs of testable sensors with 30 mA each and 64 inputs of WS0-XTIO or WS0-XTDI modules.
Test pulse rate	1 Hz to 25 Hz, configurable
Test pulse duration	1 ms to 100 ms, configurable
Load capacity	1 µF for test pulse duration ≥ 4 ms 0.5 µF for test pulse duration 1 ms
Cable resistance	< 100 Ω

Safety outputs (Q1 to Q4)

Number of outputs	4
Output type	PNP semiconductor, short-circuit protected, cross-circuit monitoring
Output voltage	24 V DC (15.6 V DC to 30 V DC)
Output current	2 A
Total current Isum	Max. 3.2 A
Test pulse width	< 650 µs
Test pulse rate	Typ. 0.8 Hz
Load capacity	≦0.5 µF
Cable length	100 m, 1.5 mm^2
Response time	Depending on the logic configuration, for details see Table 41.
Data interface	Internal bus (FLEXBUS+ backplane bus)

12.2.3 WS0-XTDI safety input module

Table 45: Data sheet WS0-XTDI

Category	Category 4 (EN ISO 13849-1) Category 4 (EN 954-1[*1])
Safety Integrity Level	SIL3 (IEC 61508)
Performance Level	PL e (EN ISO 13849-1)
PFHd	0.4E-09 1/h
TM service life	20 years
Ambient temperature in operation	-25 °C to +55 °C
Storage temperature	-25 °C to +70 °C
Humidity	10 % to 95 %, non-condensing
Climatic conditions	to EN 61131-2 (55 °C, 95 % rel. humidity), No corrosive gases
Rigidity	5 Hz to 500 Hz, tested to EN 61131-2
Enclosure rating to EN/IEC 60529	Terminals: IP 20 Housing: IP 40
Electromagnetic compatibility	EN 61000-6-2, EN 55011 (Class A)
Protection class	III
System connection	Two-tier tension-spring terminals
Power input via FLEXBUS+ without currents to X1 to X8	Max. 1.4 W
Cross-circuit of connecting wires	Single-core or finely stranded: 1 x 0.14 to 2.5 mm^2 or 2 x 0.14 to 0.75 mm^2 Finely stranded with ferrules to EN 46228: 1 x 0.25 to 2.5 mm^2 or 2 x 0.25 to 0.5 mm^2
Dimensions (W x H x D)	22.5 x 106.5 x 120.8 mm
Weight	150 g

Input circuit (I1 to I8)

Input voltage HIGH	13 V DC to 30 V DC
Input voltage LOW	-5 V DC to +5 V DC
Input current HIGH	2.4 mA to 3.8 mA
Input current LOW	-2.5 mA to 2.1 mA
Switching current (with mechanical contacts)	14.4 mA at 5 V 3 mA at 24 V
Discrepancy times	4 ms to 30 s, configurable
Number of inputs	8

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

Test outputs (X1 to X8)

Number of outputs	8 (with 2 test pulse generators)
Output type	PNP semiconductor, short-circuit protected, cross-circuit monitoring
Output voltage	16 V DC to 30 V DC
Output current	Max. 120 mA at each of the two test signal generators (X1/X3/X5/X7 or X2/X4/X6/X8) This means that a maximum of 8 testable sensor cascades per module with max. 30 mA each are possible. The total current of the MELSEC-WS safety controllers is limited to a maximum of 1.28 mA. This corresponds to e.g. 32 inputs of testable sensors with 30 mA each and 64 inputs of WS0-XTIO or WS0-XTDI modules.
Test pulse rate	1 Hz to 25 Hz, configurable
Load capacity	1 µF for test pulse duration ≥ 4 ms 0.5 µF for test pulse duration 1 ms
Cable resistance	< 100 Ω

12.2.4 WS0-4RO safety relay output module

Table 46:
Data sheet WS0-4RO

Supply circuit

Supply voltage	24 V DC (19.2 V DC to 30 V DC)
Safety extra-low voltage	If WS0-4RO is connected and loading of the output current paths: U > 25 V AC/60 V DC (PELV) U < 25 V AC/60 V DC (SELV/PELV)
Power consumption	Max. 2 W

Output circuit (13–14, 23-24, 33-34, 43-44, Y1-Y2, Y3-Y4)

Number of NO contacts	4 (13-14, 23-24, 33-34, 43-44)
Number of NC contacts	2 (Y1-Y2, Y3-Y4)
Switching voltage	250 V AC (5 V AC to 275 V AC)
	230 V DC (5 V DC to 275 V DC)
Switching current	10 mA at 5 V 2 mA at 24 V Max. 6 A
Total current	12 A
Response time (time from LOW at B1/B2 to drop relay)	30 ms
Output type	Volt-free NO contacts, positively driven (13-14, 23-24, 33-34, 43-44) Volt-free NC contacts, positively driven (Y1-Y2, Y3-Y4)
Contact material	AgSnO2 with 1 µm Au
Output circuit fusing	6 A (gG), per current path
Utilization category	AC-15: Ue 250 V, Ie 3 A
	DC-13: Ue 24 V, Ie 3 A

Output circuit (Y14, Y24)

Output type	Non-isolated NO contact, positively driven, current-limited
Number of NO contacts Y14/24	2
Output voltage	24 V DC (18 V DC to 30 V DC)
Output current	Max. 75 mA The total output current is limited. The maximum total current of all the relay modules at Y14 or Y24 is I<80 mA
Load capacity	200 nF

General data

Electrical isolation	
Supply circuit – input circuit	No
Supply circuit – output circuit	Yes
Input circuit – output circuit	Yes
Weight (without packaging)	190 g

Operating data

Ambient operating temperature	-25 °C to 55 °C
Storage temperature	-25 °C to 70°C
Humidity	10% to 95%, non-condensing
Climatic conditions	EN 61131-2, No corrosive gases

Mechanical strength

Oscillation	EN 61131-2
Vibration stability (EN 60068-2-64)	5–500 Hz/5 grms

Electrical safety EN 50178

Rated impulse withstand voltage (Vimp)	4 kV
Overvoltage category	III
Pollution degree	2 inside, 3 outside
Rated voltage	300 V AC
Enclosure rating to EN 60529 housing/terminals	IP 40/IP 20
Electromagnetic compatibility	EN 61000-6-2, EN 55011 Class A

Terminal and connection data

Single-core or finely stranded	1 x 0.14 mm² to 2.5 mm² or 2 x 0.14 mm² to 0.75 mm²
Finely stranded with ferrules to EN 46228	1 x 0.25 mm² to 2.5 mm² or 2 x 0.25 mm² to 0.5 mm²
Stripped length	8 mm
Maximum break-away torque	0.6 Nm
Functional safety in accordance with EN 954-1*1	Category 4
Functional safety in accordance with EN ISO 13849-1	Category 4
Functional safety in accordance with EN 61508	SIL3

*1 Only valid for the assumption of conformity until 29.12.2009.
For then on it will only EN ISO 13849-1.

Safety-specific characteristics

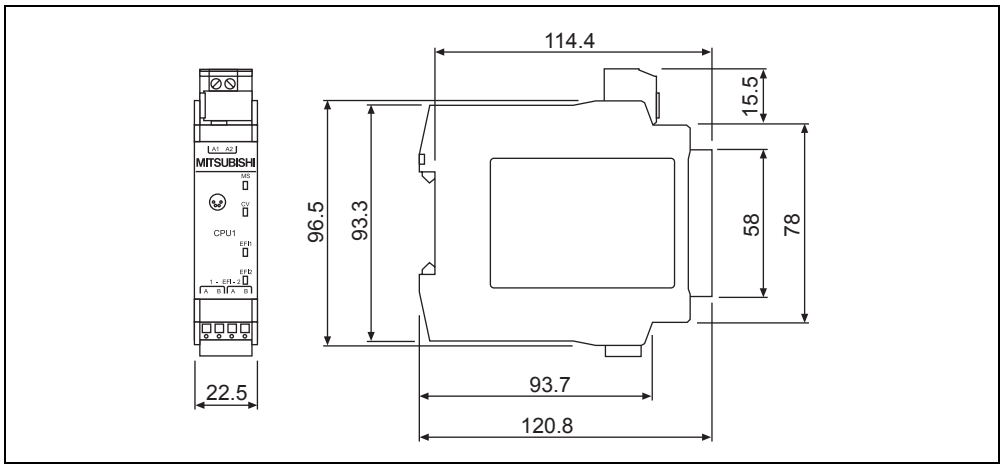
All these data are based on an ambient temperature of +55 °C.

PFD	1.6 x 10-7
PFH	1 x 10-9 h-1
SFF	99.6%
DC	99%

12.3 Dimensional drawings

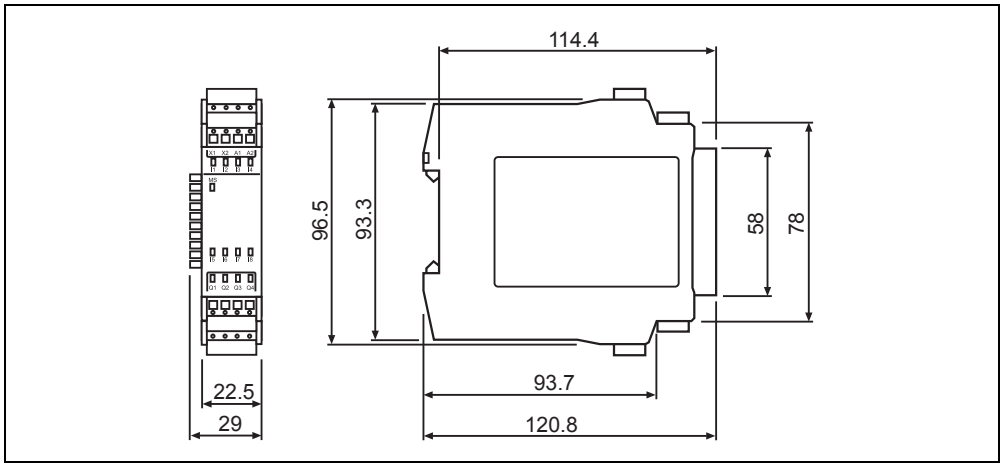
12.3.1 WS0-CPU0/CPU1 module with memory plug

Figure 23:
Dimensional drawing
WS0-CPU0/1 (mm)



12.3.2 WS0-XTIO module, WS0-XTDI module, and WS0-4RO module

Figure 24:
Dimensional drawing
WS0-XTIO, WS0-XTDI,
WS0-4RO (mm)



13 Ordering information

13.1 Available modules and accessories

Table 47:
Device types of MELSEC-WS modules

Device type	Part
WS0-MPL00201	Memory plug
WS0-CPU000200	CPU module Two-tier spring terminals
WS0-CPU130202	CPU module 2 EFI inputs Two-tier spring terminals
WS0-XTIO84202	Safety I/O combined module 8 inputs/4 outputs Two-tier spring terminals
WS0-XTDI80202	Safety input module 8 inputs Two-tier spring terminals
WS0-4RO4002	Safety relay output module 4 NO contacts and 2 24-V DC alarm signals Removable terminals
WS0-C20R2	Configuration cable 2 m, M8, Sub D
WS0-UC-232A	RS-232 USB converter, RS-232 to USB
WS0-GETH00200	Ethernet interface module for Ethernet
WS0-TBC4	4 Two-tier spring terminals (for replacement)
WS0-TBS4	4 screw terminals (for replacement)

14 Annex

14.1 EC declaration of conformity

The MELSEC-WS safety controller has been produced in accordance with the following standards:

- Machinery Directive 98/37/EC
  (from 29.12.2009 Machinery Directive 2006/42/EC)
- EMC Directive 2004/108/EC

14.2 Manufacturers checklist

Table 48: Example of the checklist for installation of the MELSEC-WS safety controller

Checklist for the manufacturer/installer for installation of the MELSEC-WS safety controller

The specifications for the following items listed must be available at least for the initial commissioning. They are dependent on the application, whose requirement must be checked by the manufacturer/installer.

This checklist should be retained/stored with the machine documentation so that you can use it as a reference for periodical tests.

1.	Have the safety rules and regulations been observed in compliance with the directives/standards applicable to the machine?	Yes	☐	No	☐
2.	Are the applied directives and standards listed in the declaration of conformity?	Yes	☐	No	☐
3.	Does the protective device comply with the required category?	Yes	☐	No	☐
4.	Are the required protective measures against electric shock in effect (protection class)?	Yes	☐	No	☐
5.	Has the protective function been checked in compliance with the test notes in this documentation? Especially: ● Functional check of the command devices, sensors and actuators connected to the safety controller ● Test of all switch-off paths	Yes	☐	No	☐
6.	Are you sure that the safety controller was tested fully for safety functionality after each configuration change?	Yes	☐	No	☐

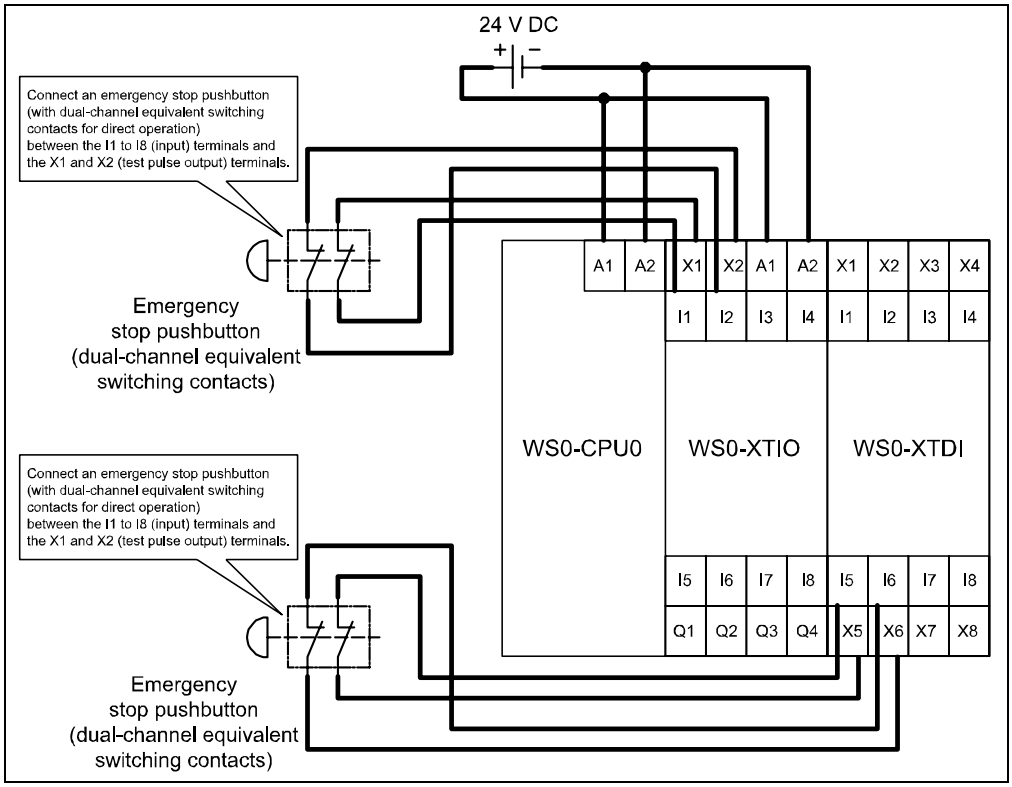
This checklist does not replace initial commissioning and regular tests by qualified safety personnel.

14.3 Wiring examples

(1) Wiring of the emergency stop pushbuttons, start switches, stop switches, and reset switches

a) Dual-channel wiring (with test pulse outputs)
Connect emergency stop pushbuttons to the MELSEC-WS safety controller as shown below.

Figure 25:
Wiring example of emergency stop pushbuttons



* Use the following terminal combinations for dual-channel input wiring.

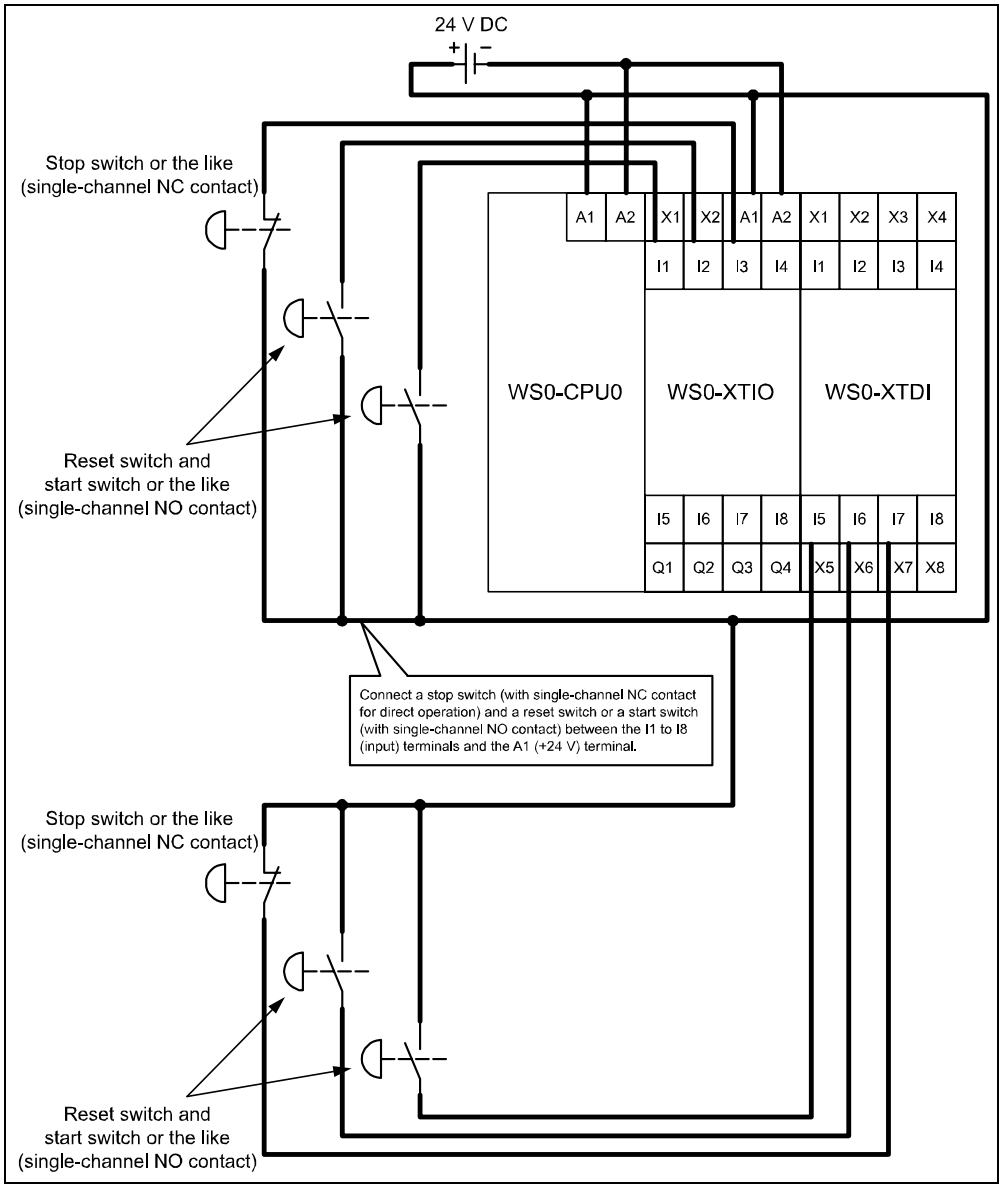
WS0-XTIO: ((I1 and X1) (I2 and X2)), ((I3 and X1) (I4 and X2)), ((I5 and X1) (I6 and X2)), ((I7 and X1) (I8 and X2))

WS0-XTDI: ((I1 and X1) (I2 and X2)), ((I3 and X3) (I4 and X4)) to ((I7 and X7) (I8 and X8))

b) Single-channel wiring (without test pulse outputs)

Connect start switches, stop switches, and reset switches to the MELSEC-WS safety controller as shown below.

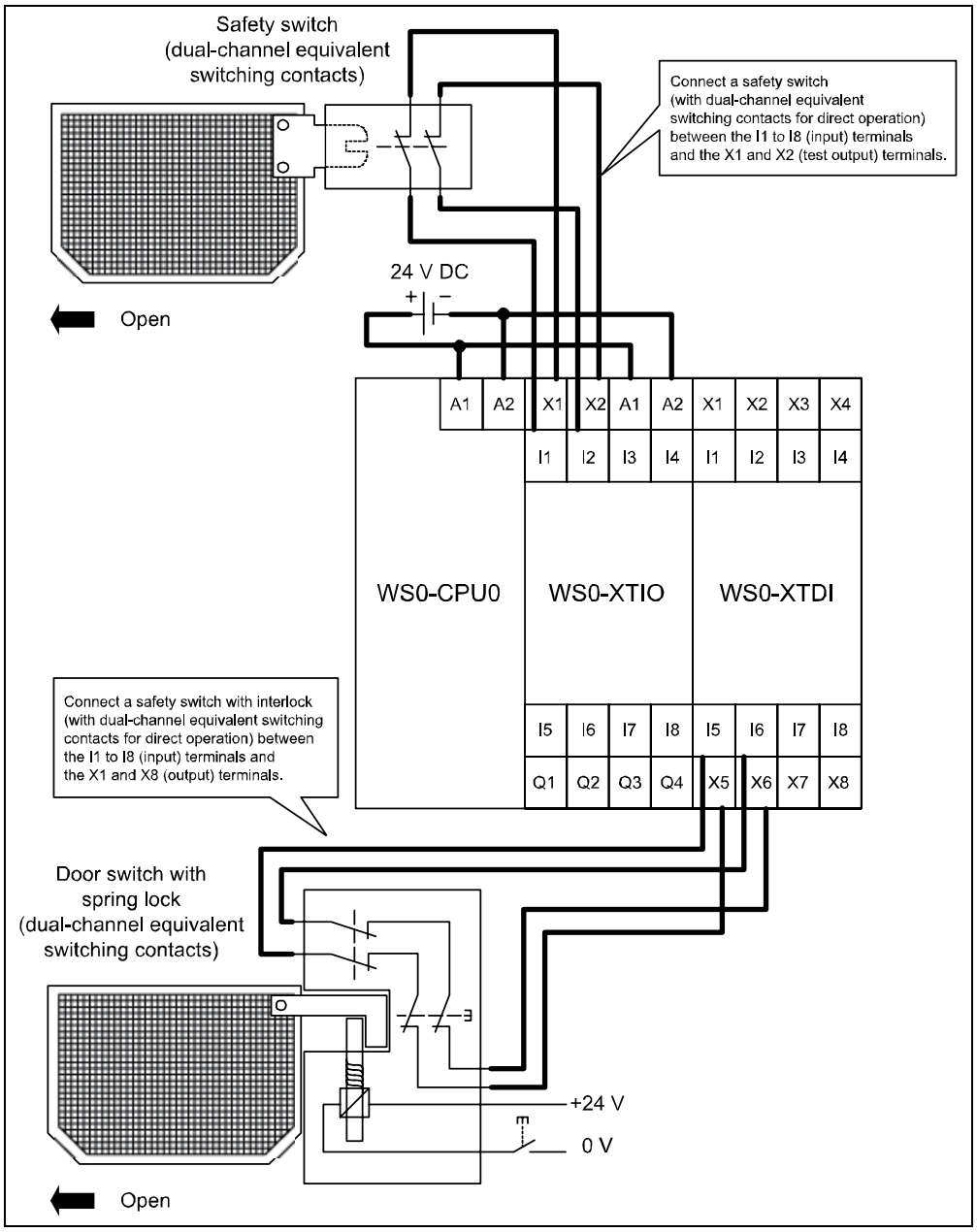
Figure 26:
Wiring example of start switches, stop switches, and reset switches



(2) Wiring of safety switches

Connect a safety switch to the MELSEC-WS safety controller as shown below.

Figure 27:
Wiring example of safety switches



* Use the following terminal combinations for dual-channel input wiring.

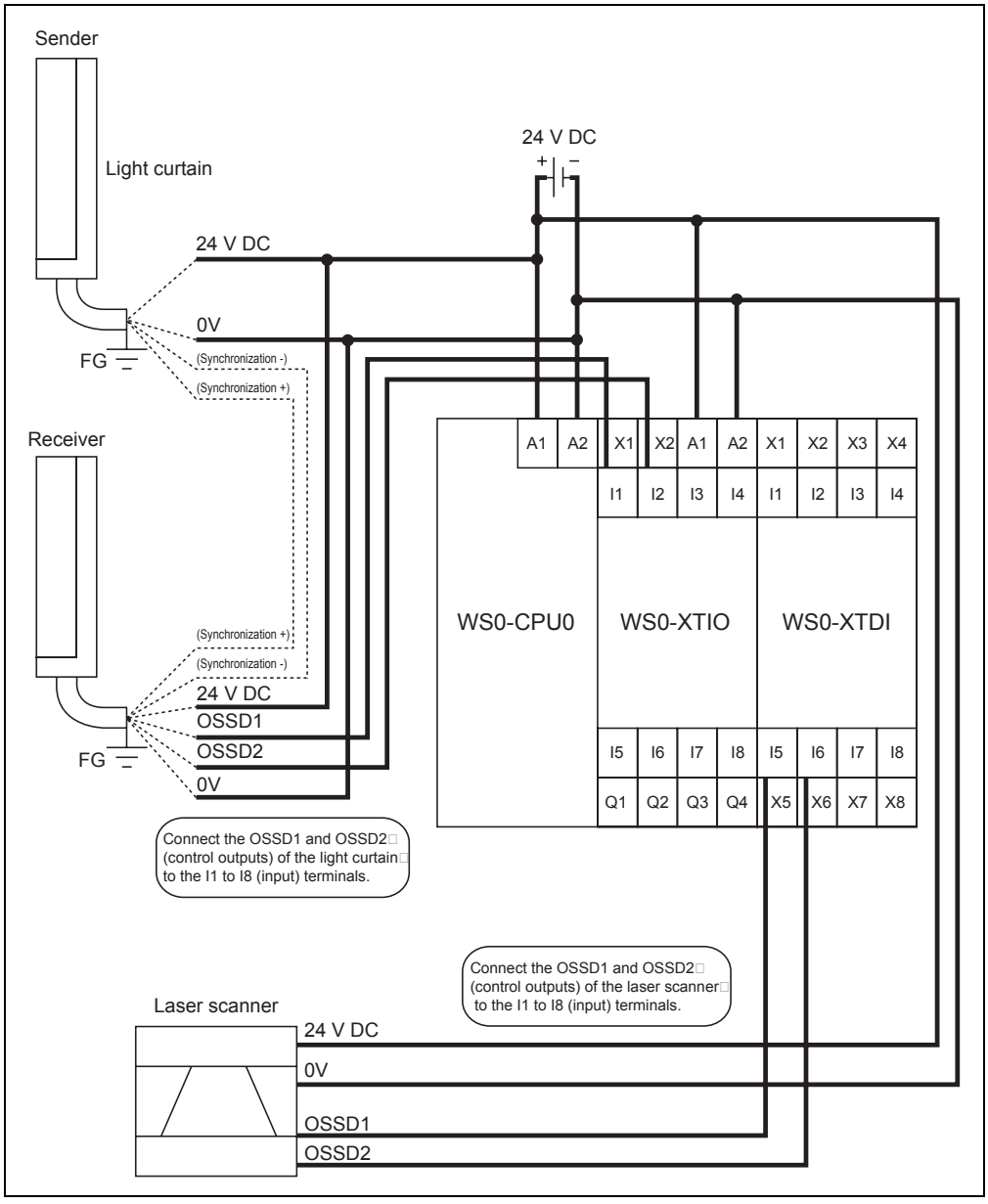
WS0-XTIO: ((I1 and X1) (I2 and X2)), ((I3 and X1) (I4 and X2)), ((I5 and X1) (I6 and X2)), ((I7 and X1) (I8 and X2))

WS0-XTDI: ((I1 and X1) (I2 and X2)), ((I3 and X3) (I4 and X4)) to ((I7 and X7) (I8 and X8))

(3) Wiring of light curtains and laser scanners

Connect a light curtain and a laser scanner to the MELSEC-WS safety controller as shown below.

Figure 28:
Wiring example of light curtain and laser scanner

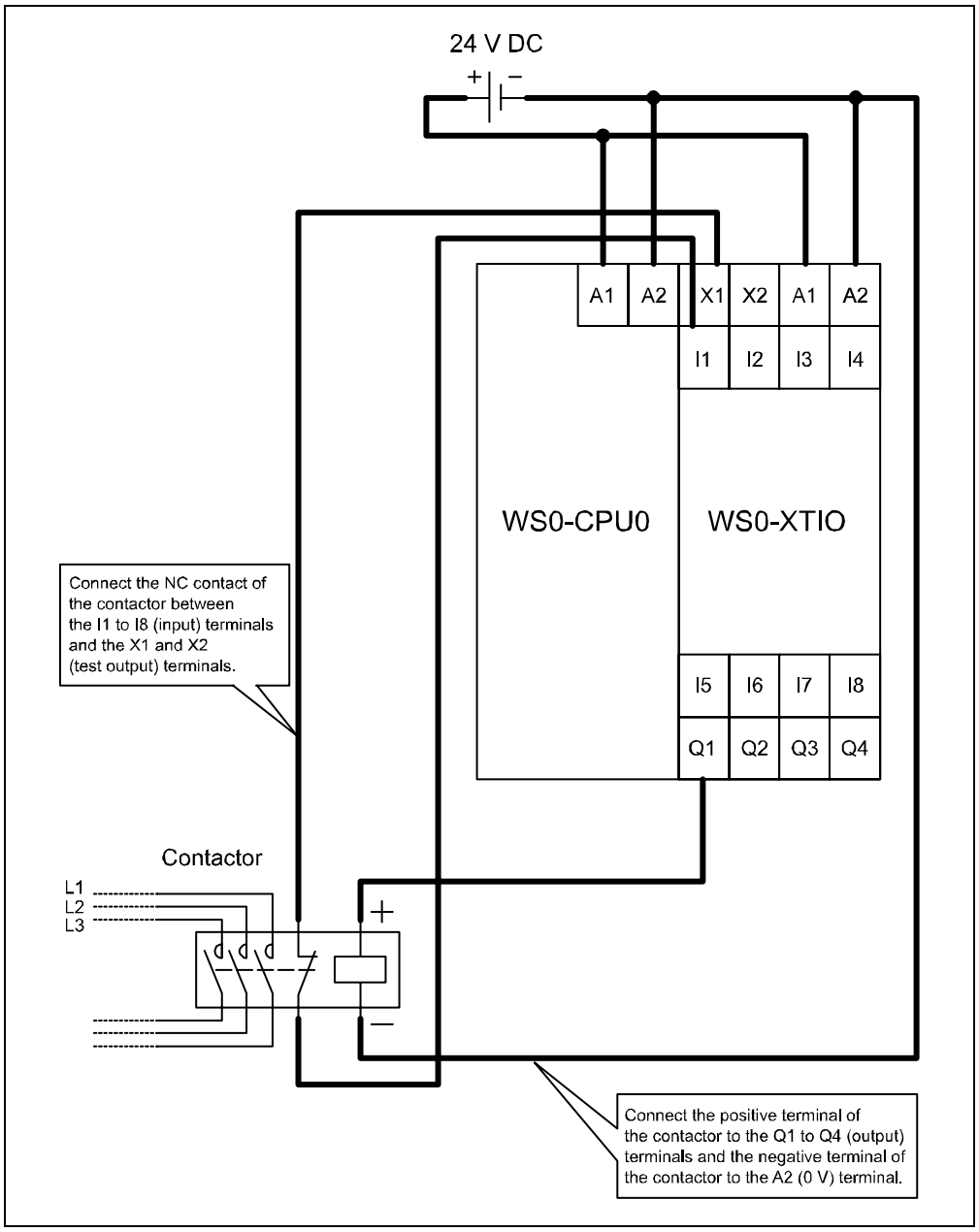


* The light curtain is connected to the WS0-XTIO and the laser scanner is connected to the WS0-XTDI in the above example. Both elements can be connected to either module.

(4) Wiring of contactors

Connect a contactor to the MELSEC-WS safety controller as shown below.

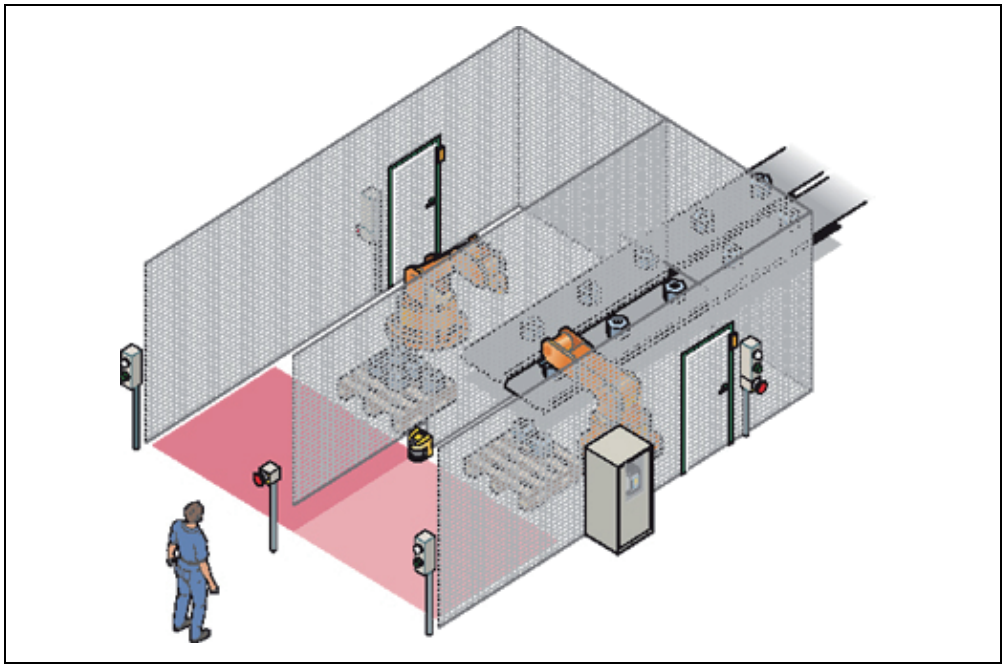
Figure 29:
Wiring example of contactor



<Application example>

Simultaneous protection from danger (Use of a laser scanner)

Figure 30:
Application example



[Function]

Two independent robots are protected with one laser scanner (S3000).

An operater can access the dangerous area through the protective area or the side gates.

When the operater opens the side gate or crossing the laser-protected area, the robots stop their operation. Both robots stop when any one of the emergency stop switches is activated.

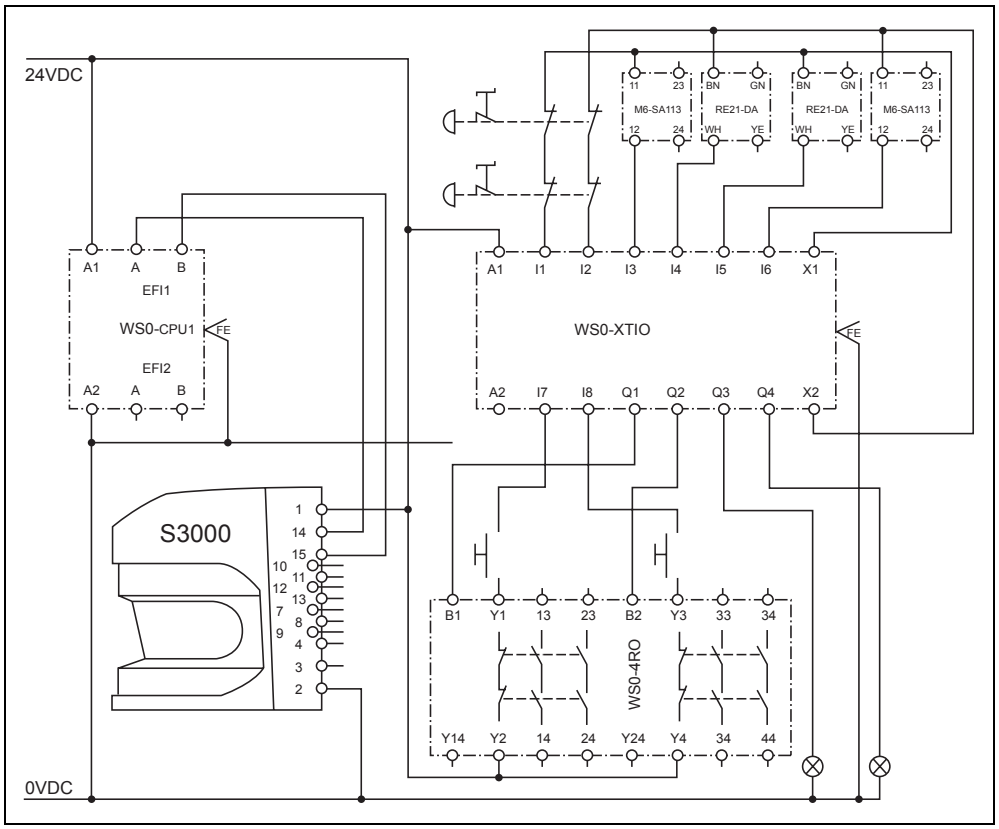
Reset the safety device after activation.

[Safety]

This system meets the performance level d in accordance with EN/ISO13849-1.

(1) Wiring

Figure 31:
Wiring of an application example



* The WS0-4RO cannot be used alone. The WS0-4RO performs the ON/OFF control via the WS0-XTIO.

Connect the output terminals (Q1 to Q4) of the WS0-XTIO to the input terminals (B1 and B2).

(2) Configuration in the Setting and Monitoring Tool

a) Hardware configuration



Figure 32:
Hardware configuration of an application example

b) Logic

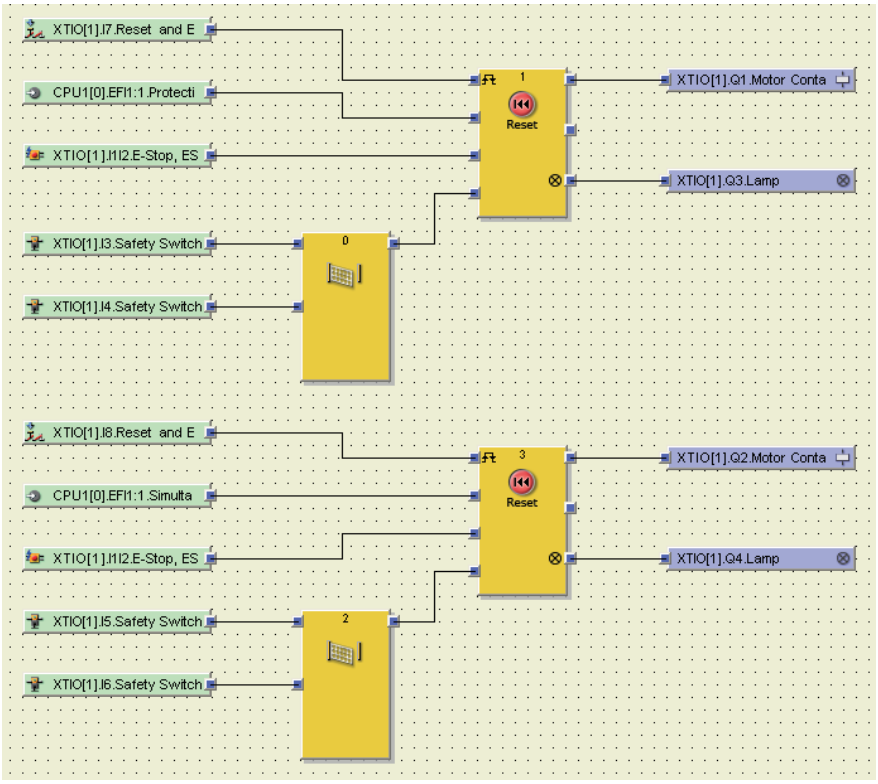


Figure 33:
Logic of an application example

14.4 Troubleshooting

This section describes errors that may occur during system operation, how to locate the errors, and measures against the errors.

14.4.1 Basics of troubleshooting

In order to increase the reliability of the system, resuming the system operation promptly after correcting a problem is one of the important factors as well as using reliable devices.

To promptly start up the system, the trouble cause must be located and eliminated correctly.

The basic three points to be followed in the troubleshooting are as follows.

(1) Visual inspection

Visually check the following.

1) Behavior of the safety controller and other connected devices
2) Applicability of the power supply
3) States of input and output devices
4) Installation states of the CPU module and safety I/O modules
5) Wiring (Power cable and I/O lines)
6) Display status of all indicators (such as MS LED and CV LED)

After checking 1) through 6), connect the Setting and Monitoring Tool and monitor the operating status and logic processing of the MELSEC-WS safety controller.

(2) Error checking

Check how the error status changes by operating the following to the safety controller.

1) Turn on or off the power supplied to the memory plug.

(3) Narrowing down the scope for identifying trouble cause

Estimate the troubled part based on the check results of the items (1) and (2) above.

1) MELSEC-WS safety controller or external devices
2) CPU module or others
3) Configuration

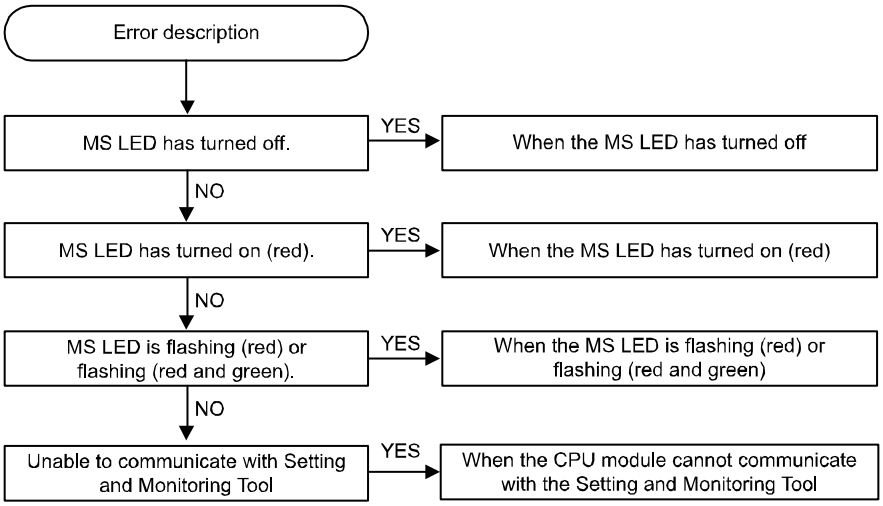
14.4.2 Troubleshooting flowchart (for CPU module)

This section describes how to identify errors and measures to eliminate the errors.

(1) Troubleshooting flowchart

The following shows the error description according to the types of events.

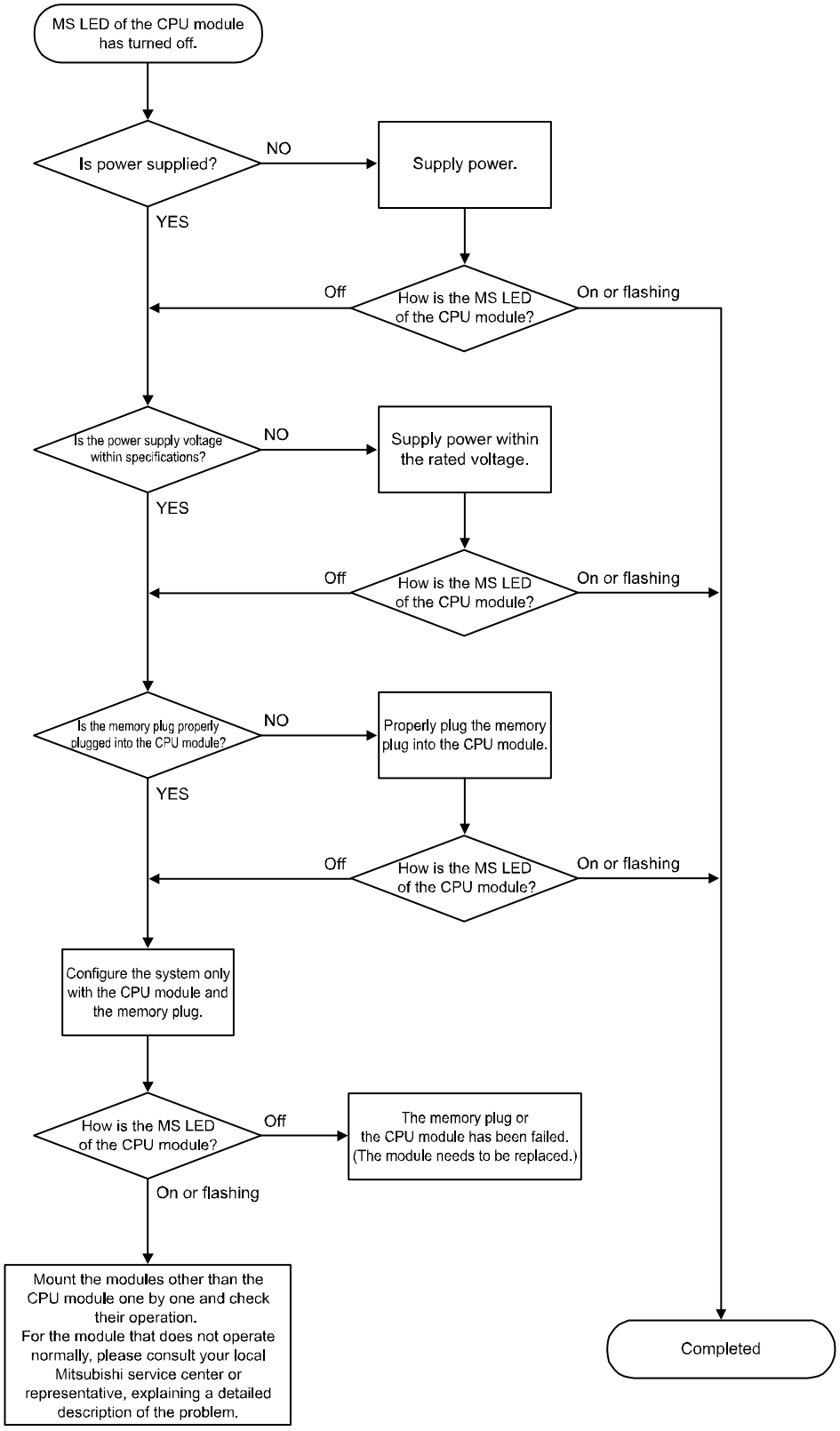
Figure 34: Troubleshooting flowchart for CPU module



(2) When the MS LED has turned off

Refer to the following flowchart when the MS LED of the CPU module has turned off at power-on or during operation of the MELSEC-WS safety controller.

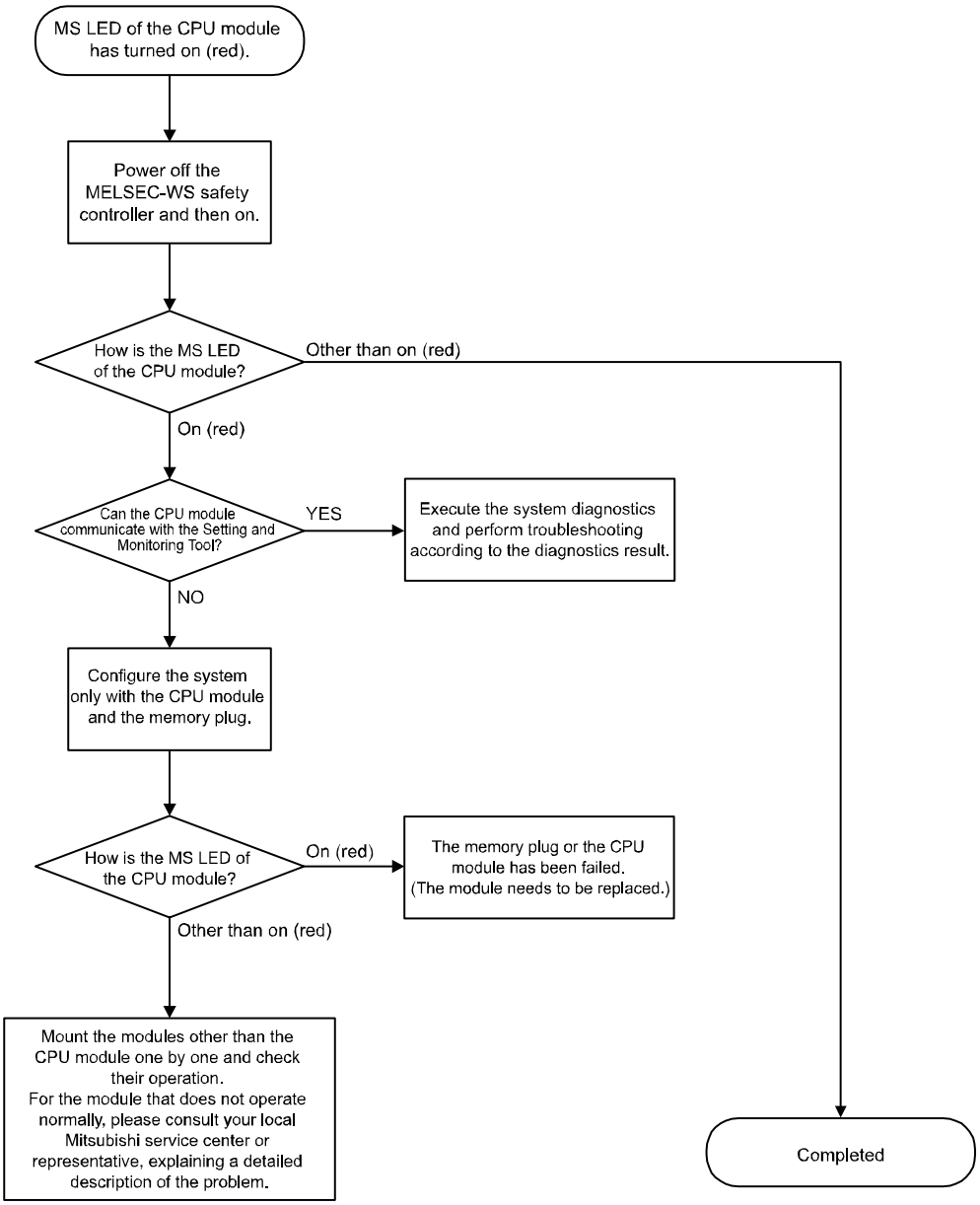
Figure 35:
Flowchart when the MS LED has turned off



(3) When the MS LED has turned on (red)

Refer to the following flowchart when the MS LED of the CPU module has turned on (red) at power-on or during operation of the MELSEC-WS safety controller.

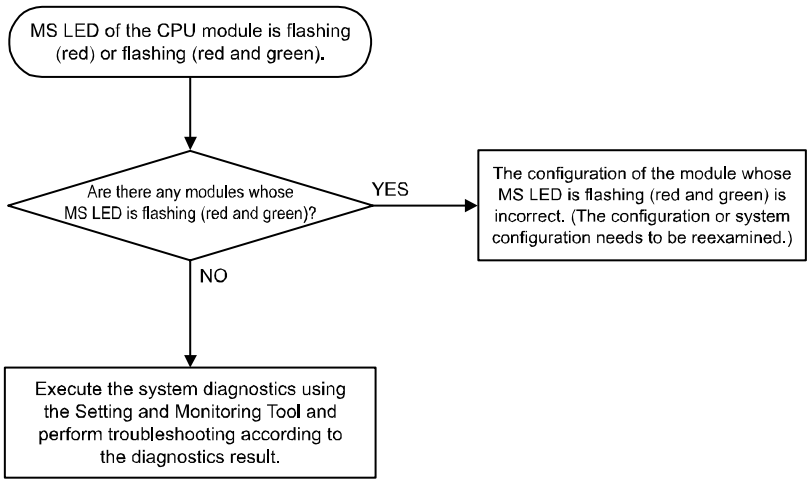
Figure 36: Flowchart when the MS LED has turned on (red)



(4) When the MS LED is flashing (red) or flashing (red and green)

Refer to the following flowchart when the MS LED of the CPU module is flashing (red) or flashing (red and green) at power-on or during operation of the MELSEC-WS safety controller.

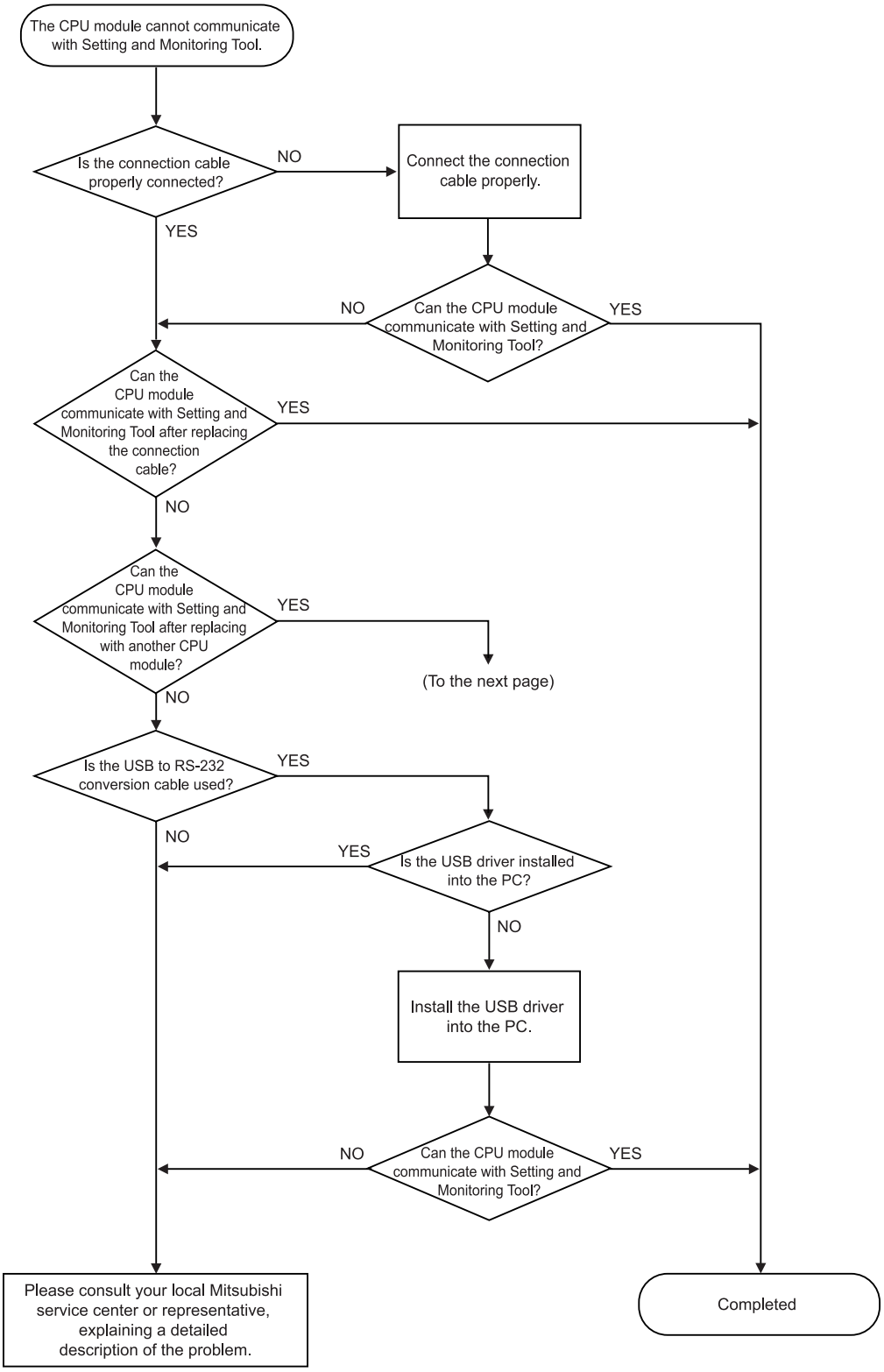
Figure 37:
Flowchart when the MS LED is flashing (red) or flashing (red and green)

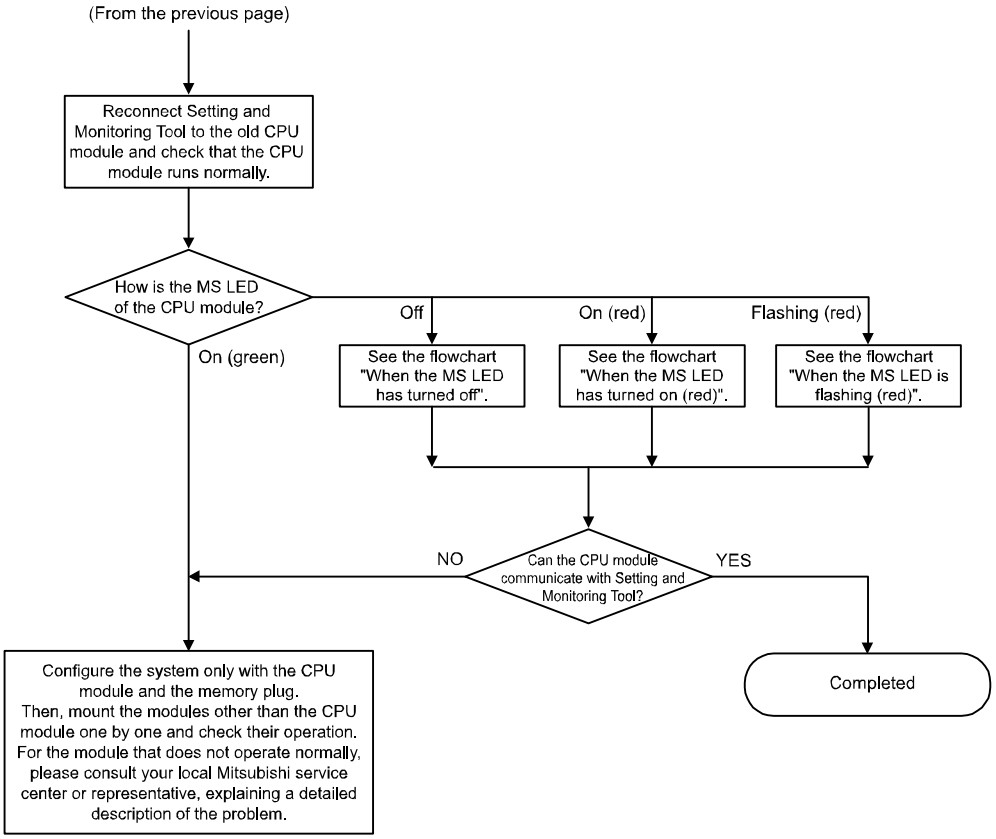


(5) When the CPU module cannot communicate with Setting and Monitoring Tool

Refer to the following flowchart when communication with a peripheral device is disabled when connecting the CPU module with Setting and Monitoring Tool.

Figure 38: Flowchart when the CPU module cannot communicate with Setting and Monitoring Tool




(From the previous page)
Reconnect Setting and Monitoring Tool to the old CPU module and check that the CPU module runs normally.
How is the MS LED of the CPU module?
Off
On (red)
Flashing (red)
On (green)
See the flowchart "When the MS LED has turned off".
See the flowchart "When the MS LED has turned on (red)".
See the flowchart "When the MS LED is flashing (red)".
NO
Can the CPU module communicate with Setting and Monitoring Tool?
YES
Configure the system only with the CPU module and the memory plug.
Then, mount the modules other than the CPU module one by one and check their operation.
For the module that does not operate normally, please consult your local Mitsubishi service center or representative, explaining a detailed description of the problem.
Completed

14.4.3 Troubleshooting flowchart (for safety I/O module)

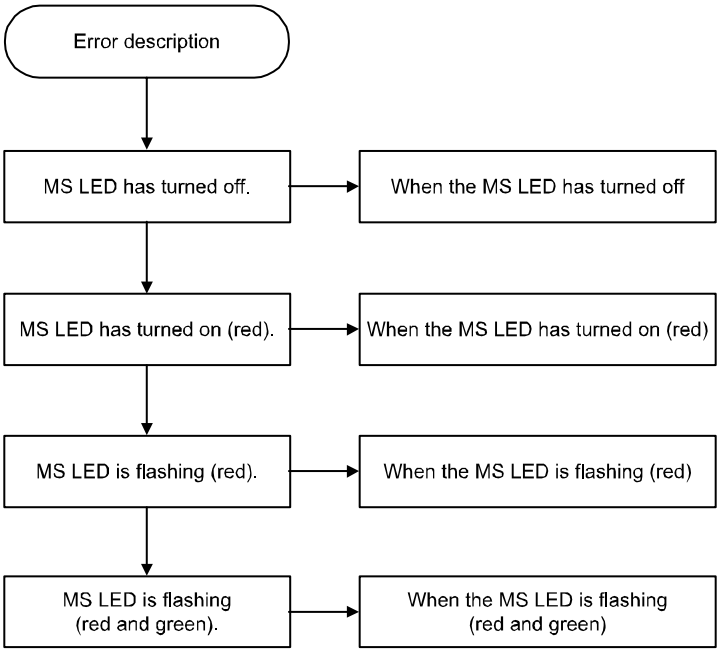
This section describes how to identify errors and measures to eliminate the errors.

- WS0-XTIO, WS0-XTDI

(1) Troubleshooting flowchart

The following shows the error description according to the types of events.

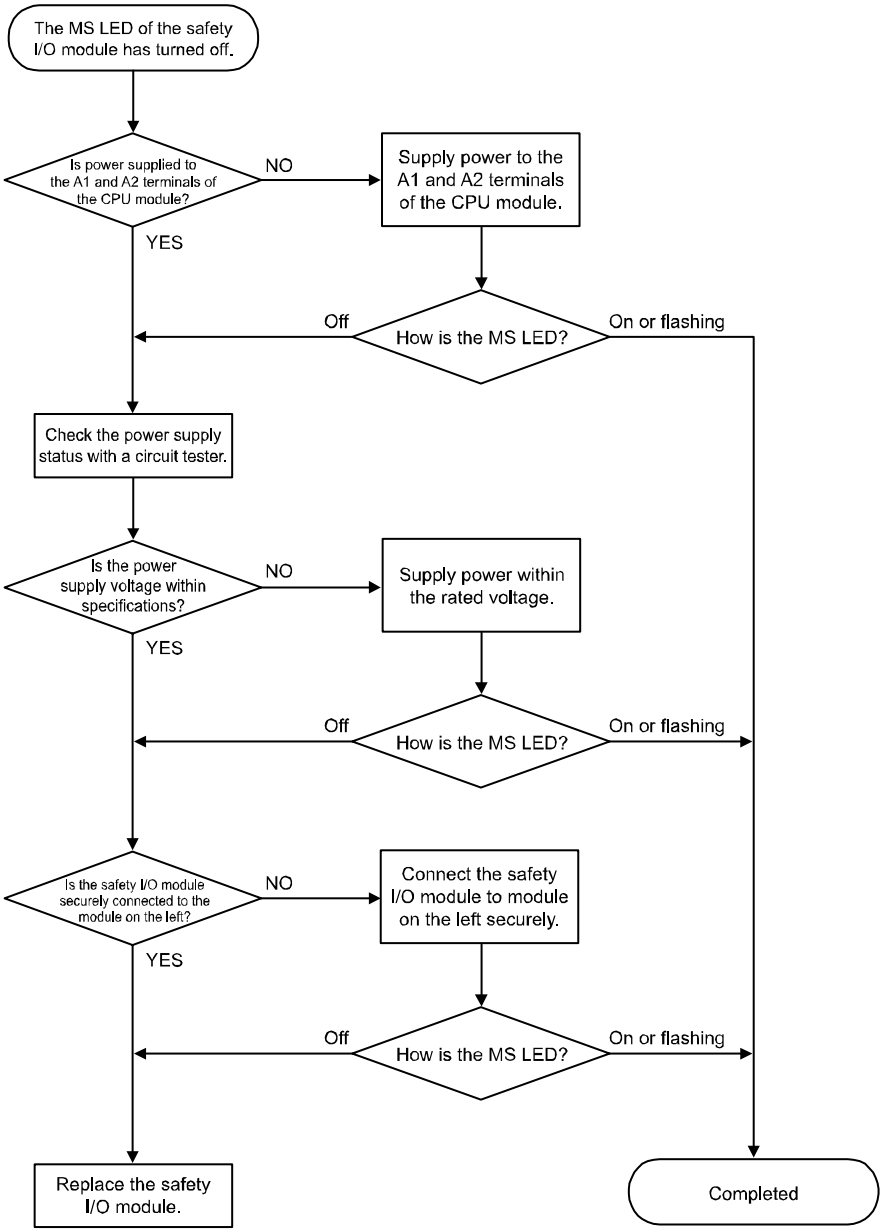
Figure 39: Troubleshooting flowchart for safety I/O module



(2) When the MS LED has turned off

Refer to the following flowchart when the MS LED of the safety I/O module has turned off at power-on or during operation of the MELSEC-WS safety controller.

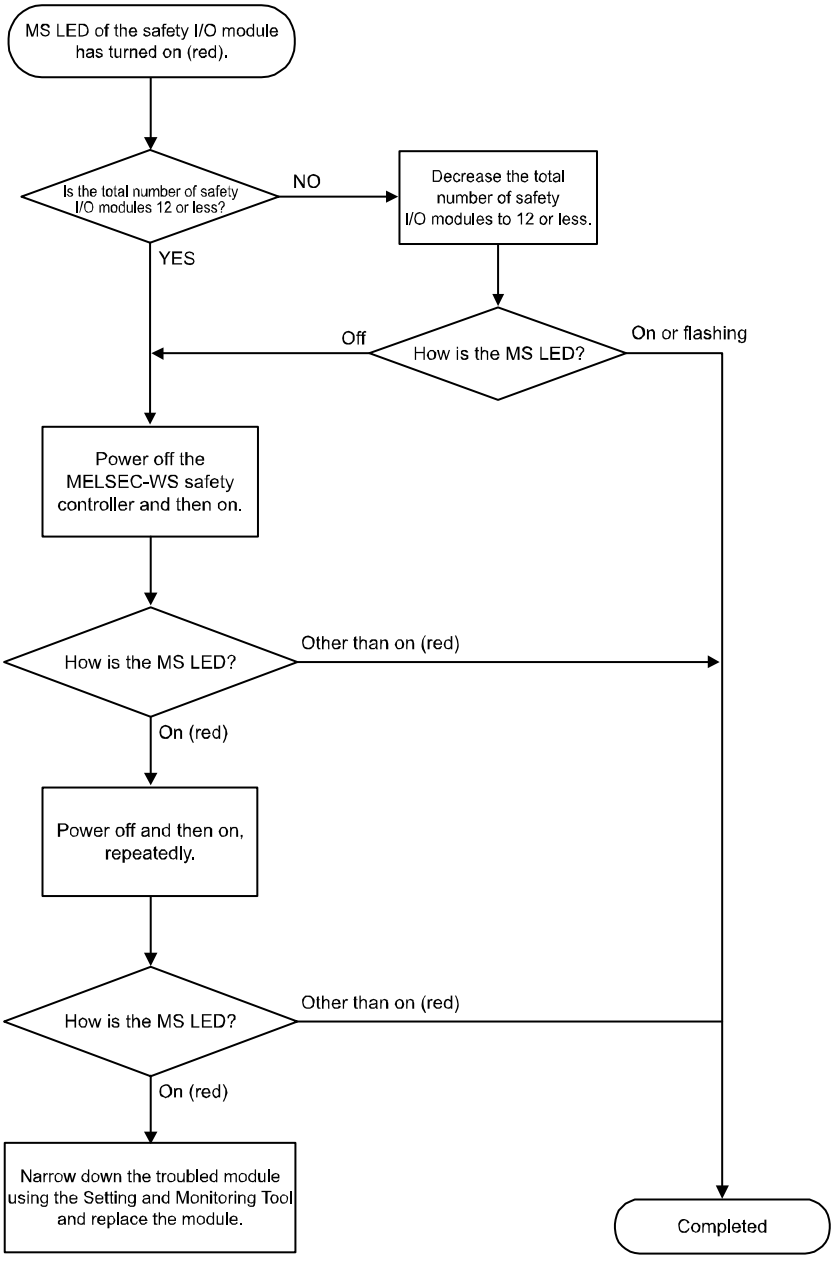
Figure 40:
Flowchart when the MS LED has turned off



(3) When the MS LED has turned on (red)

Refer to the following flowchart when the MS LED of the safety I/O module has turned on (red) at power-on or during operation of the MELSEC-WS safety controller.

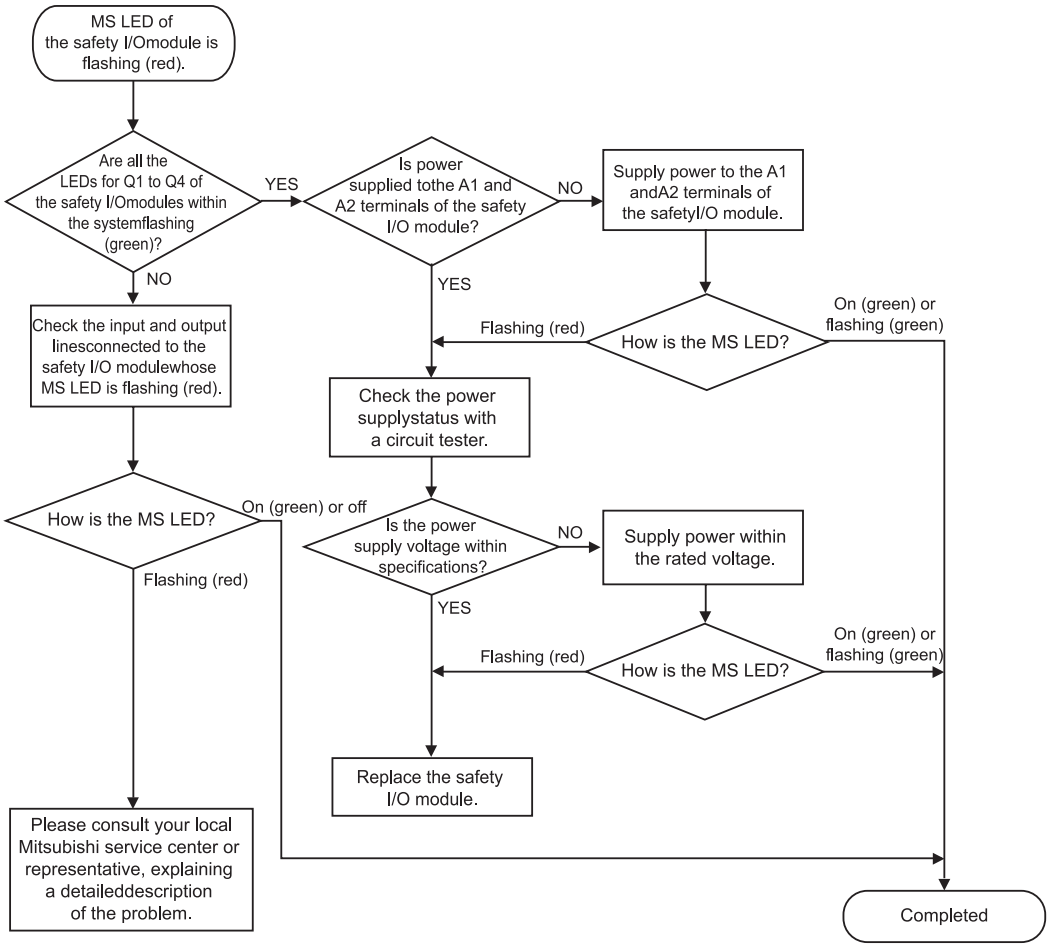
Figure 41: Flowchart when the MS LED has turned on (red)



(4) When the MS LED is flashing (red)

Refer to the following flowchart when the MS LED of the safety I/O module is flashing (red) at power-on or during operation of the MELSEC-WS safety controller.

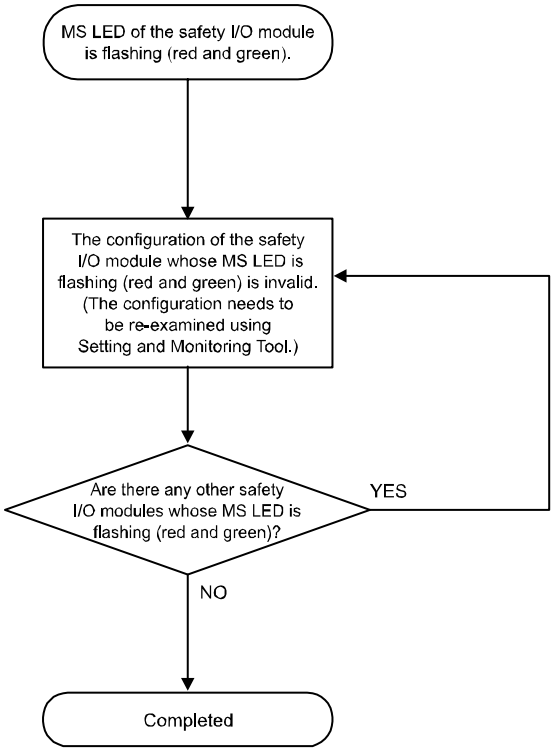
Figure 42:
Flowchart when the MS LED is flashing (red)



(5) When the MS LED is flashing (red and green)

Refer to the following flowchart when the MS LED of the safety I/O module is flashing (red and green) at power-on or during operation of the MELSEC-WS safety controller.

Figure 43:
Flowchart when the MS LED is flashing (red and green)

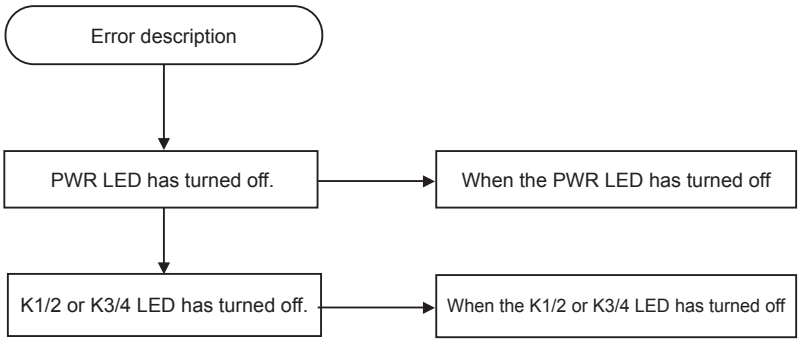


- WS0-4RO

(1) Troubleshooting flowchart

The following shows the error description according to the types of events.

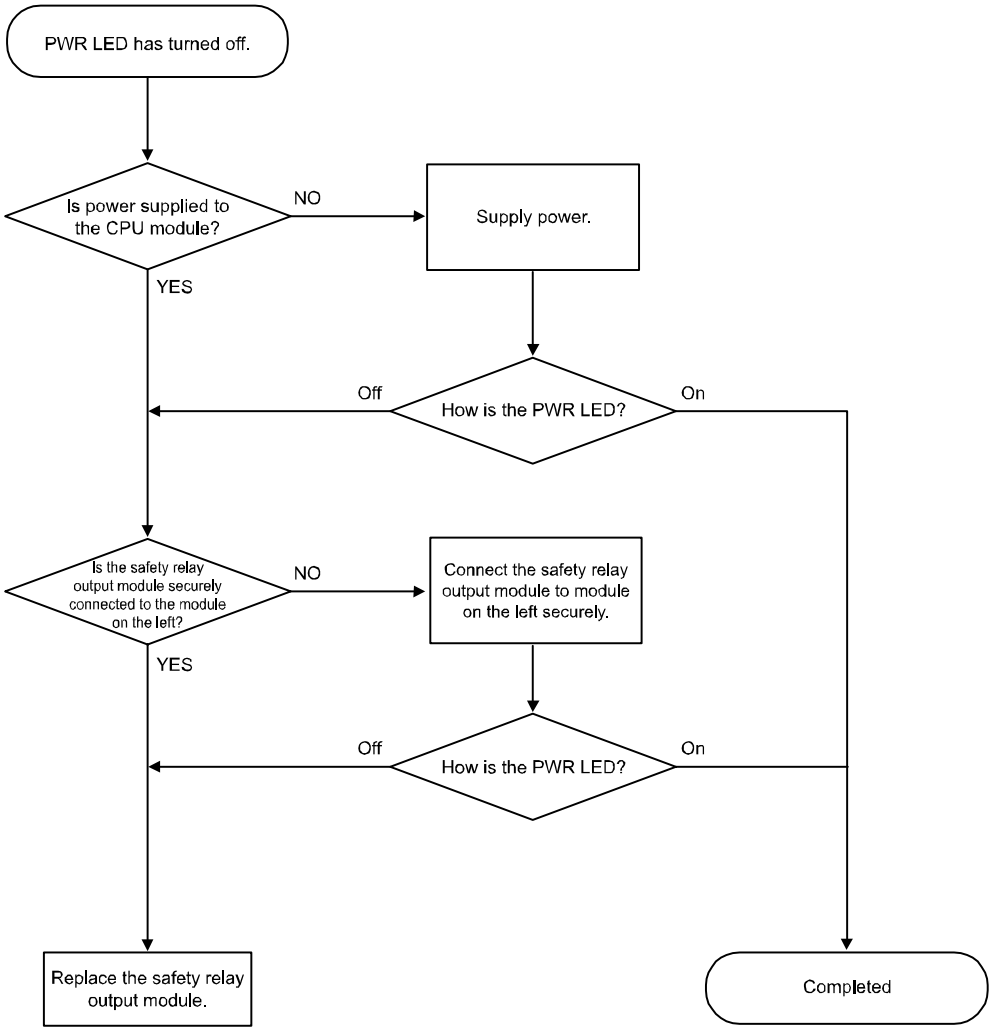
Figure 44: Troubleshooting flowchart for safety output relay module



(2) When the PWR LED has turned off

Refer to the following flowchart when the PWR LED of the safety relay output module has turned off at power-on or during operation of the MELSEC-WS safety controller.

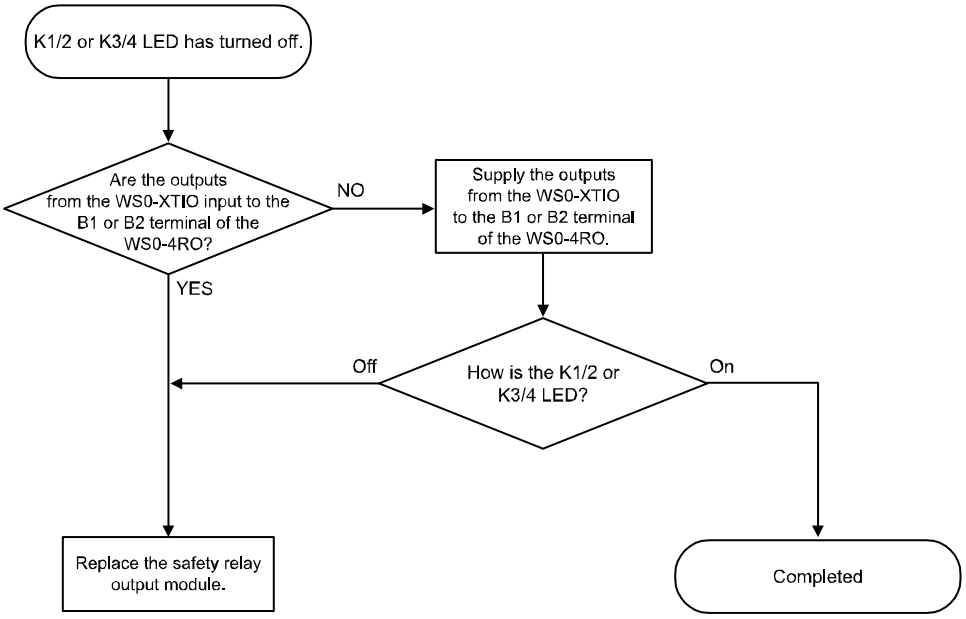
Figure 45: Flowchart when the PWR LED has turned off



(3) When the K1/2 or K3/4 LED has turned off

Refer to the following flowchart when the K1/2 or K3/4 LED of the safety relay output module has turned off at power-on or during operation of the MELSEC-WS safety controller.

Figure 46: Flowchart when the K1/2 or K3/4 LED has turned off



14.5 SICK contact

More representatives and agencies in all major industrialnations at www.sick.com

Australia
Phone +61 3 9497 4100
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Belgium/Luxembourg
Phone +32 (0)2 466 55 66
E-Mail info@sick.be

Brasil
Phone +55 11 3215-4900
E-Mail sac@sick.com.br

CeskáRepublika
Phone +420 2 57 91 18 50
E-Mail sick@sick.cz

China
Phone +852-2763 6966
E-Mail ghk@sick.com.hk

Danmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Deutschland
Phone +49 211 5301-260
E-Mail info@sick.de

España
Phone +34 93 480 31 00
E-Mail info@sick.es

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

GreatBritain
Phone +44 (0)1727 831121
E-Mail info@sick.co.uk

India
Phone +91-22-4033 8333
E-Mail info@sick-india.com

Israel
Phone +972-4-9990590
E-Mail info@sick-sensors.com

Italia
Phone +39 02 27 43 41
E-Mail info@sick.it

Japan
Phone +81 (0)3 3358 1341
E-Mail support@sick.jp

Nederlands
Phone +31 (0)30 229 25 44
E-Mail info@sick.nl

Norge
Phone +47 67 81 50 00
E-Mail austefjord@sick.no

Österreich
Phone +43 (0)22 36 62 28 8-0
E-Mail office@sick.at

Polska
Phone +48 22 837 40 50
E-Mail info@sick.pl

Republic of Korea
Phone +82-2 786 6321/4
E-Mail kang@sickkorea.net

Republika Slovenija
Phone +386 (0)1-47 69 990
E-Mail office@sick.si

Romania
Phone +40356171120
E-Mail office@sick.ro

Russia
Phone +7-495-775-05-34
E-Mail info@sick-automation.ru

Schweiz
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Singapore
Phone +65 6744 3732
E-Mail admin@sicksgp.com.sg

Suomi
Phone +358-9-25 15 800
E-Mail sick@sick.fi

Sverige
Phone +46 10 110 10 00
E-Mail info@sick.se

Taiwan
Phone +886 2 2375 -6288
E-Mail sales@sick.com.tw

Türkiye
Phone +90 216 587 74 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone + 971 4 8865 878
E-Mail info@sick.ae

USA/Canada/México
Phone +1(952) 941- 6780
1800-325-7425 – tollfree
E-Mail info@sickusa.com

WARRANTY

1. Limited Warranty and Product Support.

a. Mitsubishi Electric Company ("MELCO") warrants that for a period of eighteen (18) months after date of delivery from the point of manufacture or one year from date of Customer's purchase, whichever is less, Mitsubishi Safety Controller (the "Products") will be free from defects in material and workmanship.

b. At MELCO's option, for those Products MELCO determines are not as warranted, MELCO shall either repair or replace them or issue a credit or return the purchase price paid for them.

c. For this warranty to apply:

(1) Customer shall give MELCO (i) notice of a warranty claim to MELCO and the authorized dealer or distributor from whom the Products were purchased, (ii) the notice shall describe in reasonable details the warranty problem, (iii) the notice shall be provided promptly and in no event later than thirty (30) days after the Customer knows or has reason to believe that Products are not as warranted, and (iv) in any event, the notice must given within the warranty period;

(2) Customer shall cooperate with MELCO and MELCO's representatives in MELCO's investigation of the warranty claim, including preserving evidence of the claim and its causes, meaningfully responding to MELCO's questions and investigation of the problem, grant MELCO access to witnesses, personnel, documents, physical evidence and records concerning the warranty problem, and allow MELCO to examine and test the Products in question offsite or at the premises where they are installed or used; and

(3) If MELCO requests, Customer shall remove Products it claims are defective and ship them to MELCO or MELCO's authorized representative for examination and, if found defective, for repair or replacement. The costs of removal, shipment to and from MELCO's designated examination point, and reinstallation of repaired or replaced Products shall be at Customer's expense.

(4) If Customer requests and MELCO agrees to effect repairs onsite at any domestic or overseas location, the Customer will pay for the costs of sending repair personnel and shipping parts. MELCO is not responsible for any re-commissioning, maintenance, or testing on-site that involves repairs or replacing of the Products.

d. Repairs of Products located outside of Japan are accepted by MELCO's local authorized service facility centers ("FA Centers"). Terms and conditions on which each FA Center offers repair services for Products that are out of warranty or not covered by MELCO's limited warranty may vary.

e. Subject to availability of spare parts, MELCO will offer Product repair services for (4) years after each Product model or line is discontinued, at MELCO's or its FA Centers' rates and charges and standard terms in effect at the time of repair. MELCO usually produces and retains sufficient spare parts for repairs of its Products for a period of four (4) years after production is discontinued.

f. MELCO generally announces discontinuation of Products through MELCO's Technical Bulletins. Products discontinued and repair parts for them may not be available after their production is discontinued.

2. Limits of Warranties.

a. MELCO does not warrant or guarantee the design, specify, manufacture, construction or installation of the materials, construction criteria, functionality, use, properties or other characteristics of the equipment, systems, or production lines into which the Products may be incorporated, including any safety, fail-safe and shut down systems using the Products.

b. MELCO is not responsible for determining the suitability of the Products for their intended purpose and use, including determining if the Products provide appropriate safety margins and redundancies for the applications, equipment or systems into which they are incorporated.

c. Customer acknowledges that qualified and experienced personnel are required to determine the suitability, application, design, construction and proper installation and integration of the Products. MELCO does not supply such personnel.

d. MELCO is not responsible for designing and conducting tests to determine that the Product functions appropriately and meets application standards and requirements as installed or incorporated into the end-user's equipment, production lines or systems.

e. MELCO does not warrant any Product:

(1) repaired or altered by persons other than MELCO or its authorized engineers or FA Centers;

(2) subjected to negligence, carelessness, accident, misuse, or damage;

(3) improperly stored, handled, installed or maintained;

(4) integrated or used in connection with improperly designed, incompatible or defective hardware or software;

(5) that fails because consumable parts such as relay, batteries, backlights, or fuses were not tested, serviced or replaced;

(6) operated or used with equipment, production lines or systems that do not meet applicable and commensurate legal, safety and industry-accepted standards;

(7) operated or used in abnormal applications;

(8) installed, operated or used in contravention of instructions, precautions or warnings contained in MELCO's user, instruction and/or safety manuals, technical bulletins and guidelines for the Products;

(9) used with obsolete technologies or technologies not fully tested and widely accepted and in use at the time of the Product's manufacture;

(10) subjected to excessive heat or moisture, abnormal voltages, shock, excessive vibration, physical damage or other improper environment; or

(11) damaged or malfunctioning due to Acts of God, fires, acts of vandals, criminals or terrorists, communication or power failures, or any other cause or failure that results from circumstances beyond MELCO's control.

f. All Product information and specifications contained on MELCO's website and in catalogs, manuals, or technical information materials provided by MELCO are subject to change without prior notice.

g. The Product information and statements contained on MELCO's website and in catalogs, manuals, technical bulletins or other materials provided by MELCO are provided as a guide for Customer's use. They do not constitute warranties and are not incorporated in the contract of sale for the Products.

h. These terms and conditions constitute the entire agreement between Customer and MELCO with respect to warranties, remedies and damages and supersede any other understandings, whether written or oral, between the parties. Customer expressly acknowledges that any representations or statements made by MELCO or others concerning the Products outside these terms are not part of the basis of the bargain between the parties and are not factored into the pricing of the Products.

i. THE WARRANTIES AND REMEDIES SET FORTH IN THESE TERMS ARE THE EXCLUSIVE AND ONLY WARRANTIES AND REMEDIES THAT APPLY TO THE PRODUCTS.

j. MELCO DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

3. Limits on Damages.

a. MELCO'S MAXIMUM CUMULATIVE LIABILITY BASED ON ANY CLAIMS FOR BREACH OF WARRANTY OR CONTRACT, NEGLIGENCE, STRICT TORT LIABILITY OR OTHER THEORIES OF RECOVERY REGARDING THE SALE, REPAIR, REPLACEMENT, DELIVERY, PERFORMANCE, CONDITION, SUITABILITY, COMPLIANCE, OR OTHER ASPECTS OF THE PRODUCTS OR THEIR SALE, INSTALLATION OR USE SHALL BE LIMITED TO THE PRICE PAID FOR PRODUCTS NOT AS WARRANTED.

b. Although MELCO has obtained the certification for Product's compliance to the international safety standards IEC61508 and EN954-1/ISO13849-1 from TUV Rheinland, this fact does not guarantee that Product will be free from any malfunction or failure. The user of this Product shall comply with any and all applicable safety standard, regulation or law and take appropriate safety measures for the system in which the Product is installed or used and shall take the second or third safety measures other than the Product. MELCO is not liable for damages that could have been prevented by compliance with any applicable safety standard, regulation or law.

c. MELCO prohibits the use of Products with or in any application involving power plants, trains, railway systems, airplanes, airline operations, other transportation systems, amusement equipments, hospitals, medical care, dialysis and life support facilities or equipment, incineration and fuel devices, handling of nuclear or hazardous materials or chemicals, mining and drilling, and other applications where the level of risk to human life, health or property are elevated.

d. MELCO SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR PUNITIVE DAMAGES, FOR LOSS OF PROFITS, SALES, OR REVENUE, FOR INCREASED LABOR OR OVERHEAD COSTS, FOR DOWNTIME OR LOSS OF PRODUCTION, FOR COST OVERRUNS, OR FOR ENVIRONMENTAL OR POLLUTION DAMAGES OR CLEAN-UP COSTS, WHETHER THE LOSS IS BASED ON CLAIMS FOR BREACH OF CONTRACT OR WARRANTY, VIOLATION OF STATUTE, NEGLIGENCE OR OTHER TORT, STRICT LIABILITY OR OTHERWISE.

e. In the event that any damages which are asserted against MELCO arising out of or relating to the Products or defects in them, consist of personal injury, wrongful death and/or physical property damages as well as damages of a pecuniary nature, the disclaimers and limitations contained in these terms shall apply to all three types of damages to the fullest extent permitted by law. If, however, the personal injury, wrongful death and/or physical property damages cannot be disclaimed or limited by law or public policy to the extent provided by these terms, then in any such event the disclaimer of and limitations on pecuniary or economic consequential and incidental damages shall nevertheless be enforceable to the fullest extent allowed by law.

f. In no event shall any cause of action arising out of breach of warranty or otherwise concerning the Products be brought by Customer more than one year after the cause of action accrues.

g. Each of the limitations on remedies and damages set forth in these terms is separate and independently enforceable, notwithstanding the unenforceability or failure of essential purpose of any warranty, undertaking, damage limitation, other provision of these terms or other terms comprising the contract of sale between Customer and MELCO.

4. Delivery/Force Majeure.

a. Any delivery date for the Products acknowledged by MELCO is an estimated and not a promised date. MELCO will make all reasonable efforts to meet the delivery schedule set forth in Customer's order or the purchase contract but shall not be liable for failure to do so.

b. Products stored at the request of Customer or because Customer refuses or delays shipment shall be at the risk and expense of Customer.

c. MELCO shall not be liable for any damage to or loss of the Products or any delay in or failure to deliver, service, repair or replace the Products arising from shortage of raw materials, failure of suppliers to make timely delivery, labor difficulties of any kind, earthquake, fire, windstorm, flood, theft, criminal or terrorist acts, war, embargoes, governmental acts or rulings, loss or damage or delays in carriage, acts of God, vandals or any other circumstances reasonably beyond MELCO's control.

5. Choice of Law/Jurisdiction.

These terms and any agreement or contract between Customer and MELCO shall be governed by the laws of the State of New York without regard to conflicts of laws. To the extent any action or dispute is not arbitrated, the parties consent to the exclusive jurisdiction and venue of the federal and state courts located in the Southern District of the State of New York. Any judgment there obtained may be enforced in any court of competent jurisdiction.

6. Arbitration.

Any controversy or claim arising out of, or relating to or in connection with the Products, their sale or use or these terms, shall be settled by arbitration conducted in accordance with the Center for Public Resources (CPR) Rules for Non-Administered Arbitration of International Disputes, by a sole arbitrator chosen from the CPR's panels of distinguished neutrals. Judgment upon the award rendered by the Arbitrator shall be final and binding and may be entered by any court having jurisdiction thereof. The place of the arbitration shall be New York City, New York. The language of the arbitration shall be English. The neutral organization designated to perform the functions specified in Rule 6 and Rules 7.7(b), 7.8 and 7.9 shall be the CPR.

Microsoft, Windows, Windows NT, and Windows Vista are registered trademarks of Microsoft Corporation in the United States and other countries.
Pentium is a trademark of Intel Corporation in the United States and other countries.
Ethernet is a trademark of Xerox Corporation.
All other company names and product names used in this manual are trademarks or registered trademarks of their respective companies.

SH-(NA)-080855ENG-A

Safety Controller
User's Manual

SICK SICK AG Tel. +49 7681 202-0 http://www.sick.com

MODEL	WS-CPU-U-E
MODEL CODE	13JZ32
SH(NA)-080855ENG-A(0909)MEE	

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE : TOKYO BUILDING, 2-7-3 MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN
NAGOYA WORKS : 1-14 , YADA-MINAMI 5-CHOME , HIGASHI-KU, NAGOYA , JAPAN

When exported from Japan, this manual does not require application to the Ministry of Economy, Trade and Industry for service transaction permission.

Specifications subject to change without notice.